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THE

JOURNAL OF SCIENCE.

APRIL, 1883.

I. PARACELSUS.*

By CONSTANCE C. W. NADEN.

"If I had time to attend to such matters I would send the Pope and the Reformers to school."—PARACELSUS.

PERHAPS I ought to apologise for occupying the time of Science students with an account of one generally described as a disreputable quack. Yet I take heart of grace on reflecting that this seeming charlatan was a great power for good and evil in his own time, and has bequeathed to us certain practical benefits, a few striking ideas, and the impression of a very original and vivid personality.

To study profitably the problems involved in the life and labours of Paracelsus we should recall the tendencies, with regard to science and speculation, of the age in which he lived. He was born in 1493, the year after the discovery of the New World,—nearly fifty years after the invention of printing,—at the noon of the Renaissance and the dawn of the Reformation. The period of his life was a time of flux, of rapid growth, fervid and bright with the agitation of new and old ideas. In spite of the enthusiasm with which the Humanists had exalted Plato, the authority of Aristotle remained supreme in physical research; and since more accurate versions of his works had appeared, the verbose argumentations of the Schools were beginning to be dis-

* Read at a meeting of the Mason College Union, Birmingham, February 16th, 1883.

credited, and something of the spirit, as well as of the mere letter, of his system was being infused into the new generation of students. But Science was still in its infancy. Astronomy awaited the publication, in 1541, of the Copernican "De Revolutionibus." Chemistry was in process of budding off from its parent Alchemy, aided by Basil Valentine, Agricola, and Paracelsus himself. Anatomy was in an inchoate condition, the human body not having been systematically depicted and described before Vesalius, in 1541. Botany was not much further developed, most of the information given in text-books being taken from Greek and Latin authors, until the Commentaries of Fuchs were published in 1542. Medicine had not advanced since Hippocrates and Galen, who still held sovereign sway in the Universities.

The province of Science was not yet distinctly marked off from that of Poetry, and the mysterious and miraculous found ready credence, whether for its own intrinsic fascination or because it had received the sanction of some venerated name. Yet a true spirit of inductive research was beginning to make itself felt, though, like a pilgrim doing penance on his way to a sacred shrine, it seemed to "take three steps in advance, and one reluctantly backward." New experiments were liable to be discredited by ancient authority, and there were many who would rather doubt their own eyesight than the dictum of Aristotle,—yet these new experiments were repeated and varied again and again, till eyes could no longer refuse to see, nor ears to hear. But if the Old Learning was obstinate, the New was oftimes presumptuous; if the Old was deaf and blind, the New was dazzled by a play of prismatic colours and confused by a medley of discordant notes. The two opposing tendencies of the time are well typified by a scene in the first and one in the second part of "Faust." In the first, Mephistopheles, disguised as a professor, is ironically commending to a bewildered little freshman the study of Theology. And what he says of Theology might well, in the days of Paracelsus, have been said of all sciences as taught in the Universities.

Mephistopheles.—"You'll always find it best to hear but one;
Swear by your master's words alone.
But stick to words, at any rate,
And enter by this certain gate
Into the temple of the True."

Freshman.— "But with the words must be ideas too."

Mephistopheles.—"Quite right! but spare your too uneasy virtue,
For when ideas all desert you
A lucky word comes in and helps you through.
With words right well we wage our quarrels,
Words fashion codes of thought and morals,
Faith built of words can ne'er be brittle,
Since from a word you can't take jot or tittle."

But later on, in the second part, Mephistopheles again meets the student, who is now a Baccalaureus, and accosts his quondam preceptor with magnificent insolence. In the course of the dialogue he says—

"I practise Youth's pre-eminent vocation,—
Before me was no world,—'t is my creation:*
'T was I who raised the sun from out the sea;
The moon began her changeful course with me;
Day decked herself in dazzling robes to meet me;
Earth budded forth with leaves and flowers to greet me;
I gave the signal on that primal night,
When all the host of heaven burst forth in light.
Who but myself saves man from the dominion
Of dogmas cramping, crushing, Philistinian?
So, free and gay, my spirit's voice I heed,
And follow where the inner light may lead,
Still hasting onward with a gladsome mind,
The Bright before me, and the Dark behind."

These latter lines may stand very fairly for the self-painted portrait of Paracelsus, or, to give him his full title, of Philippus Aureolus Theophrastus Bombastes von Hohenheim. The name by which he is usually known seems to be a bad translation of his patronymic. His father, a physician and alchemist, living at Einsiedeln, not far from Zurich, doubtless initiated him into the elements of the chemistry and medicine of those days; and although little can be ascertained respecting his early history, it is probable that he studied at Basel in his sixteenth year, took a regular degree,—though in what University does not appear,—and served for some time as an army surgeon in Italy and the Netherlands. However this may be, it is certain that he soon began to wander far and wide in quest of knowledge. He visited the Universities of France, Germany, and Italy; but his independent spirit revolted against the slavish veneration paid to the classics of his profession, and rushed to

* A pretentious claim, virtually identical with that of Lord Bacon in his Introduction to the "Novum Organon":—"*Ut opis mentis universum de integro resumatur*"—a claim acquiesced in by the common opinion of contemporary physicists who believe in a total breach of continuity between ancient and mediæval traditions and existing science. (*See* Preface to STALLO'S Concepts and Theories of Modern Physics.)

the other extreme of disregarding them altogether. "Reading," he said, "never made a physician. Countries are the leaves of Nature's code of laws; patients his only books." He even states that at one time he did not open a book for ten years. Instead, therefore, of pursuing a regular course of study, he led the life of a vagrant scholar, roaming through Prussia, Poland, Transylvania, Bohemia, Sweden, Spain, Portugal, and even extending his travels as far as Constantinople and Tartary, in search, it is said, of the tincture of Hermes Trismegistus, better known as the Elixir of Life or Universal Medicine. He sought new and strange information in the most obscure quarters, conversing not only with learned men, but with old women, peasants, and conjurors, picking up stray fragments of fact and fable, and welding the whole into a system by that innate originative power which he believed himself to possess in an exceptional degree. He learnt the remedies by which the beldames cured their aches and pains; listened to the wondrous tales of magicians, endeavouring to extract their hidden truth; descended mines and examined the ores; and experimented with various chemicals upon human patients, and—*pace* our Anti-Vivisectionists—probably upon animals. Besides much dross, he managed to gather some very pure gold. He was the first who introduced mercury into the pharmacopœia, or at least the first who proved its efficacy on any extensive scale. The remarkable cures which he accomplished gave rise to a popular belief, apparently countenanced by himself, that he was in possession of a medicine which materially prolonged the normal life of man, though the power of conferring actual immortality was not attributed to the Elixir Vitæ till a later period. His correspondence with Erasmus shows the estimation in which his talents were held by that distinguished scholar, and in 1526 his fame won him a recommendation from the learned Oecolampadius to the chair of Physic and Surgery at Basel. But for this post he was unfitted by temperament and education. His disposition was haughty and impatient, and his disdain of views then regarded as established rested for the most part not on sound inductions, but on the inspirations of an enthusiastic genius which could not be expounded in any lucid form. The commencement of his course of lectures is characteristic of the man. Setting fire to some sulphur in a brazen chafing-dish, he threw into the flames the treatises of Galen and Avicenna, exclaiming "*Sic vos ardebitis in gehennâ.*" He further went on to state that all universities were less gifted than the mere hairs of his own head, and that none

of all the ancients was worthy to fasten his shoe-latchets. "You shall follow me," he cried,—"you, Avicenna, Galen, Rhasis; you gentlemen of Paris, Cologne, Vienna, and whomsoever the Rhine and Danube nourish,—you who inhabit the isles of the sea,—you likewise Dalmatians, Athenians, thou Arab, thou Greek, thou Jew,—all shall follow me, and the monarchy shall be mine." Even in an age which allowed far greater exaltation of self and depreciation of others than would now be considered permissible, this rhodomontade was sufficiently remarkable to confer a new meaning upon one of his names—*Bombast*. In opposition to the usual practice, his lectures were delivered in German (possibly because he was a poor Latin scholar), and were at first largely attended by all classes. But if his Latin would have been darkness that might be felt, his German was, to its auditors at least, little better than darkness visible. Hitherto he had confined his intemperance to language, and had lived chiefly on bread and water; but about this time he fell from ascetic purity to the grossest besottedness, and it is even said that his lectures owed all their fire and force to deep potations, and that he never came sober to the bedside of a patient. These habits naturally tended to increase the normal obscurity of his language and to repel his hearers, who fell off one by one—some, perhaps, having seized the cardinal points of his system, which, when clothed in clearer words, might pass as original; some, thinking that they had now spied out the nakedness of this intellectual Canaan; and the greater number, doubtless, from sheer weariness or disgust. At last matters were brought to a crisis by a quarrel between the professor and a canon of the church named Cornelius Lichtenfels, who had promised, in the agonies of gout, to pay a thousand florins for a cure. The cure was effected, but the florins withheld. Paracelsus brought an action at law for the recovery of his fee, but the case was decided against him. He flew into a violent rage, and applied such opprobrious epithets to his ungrateful patient, and to the magistrate who had pronounced the adverse decision, that the town council took the matter up, and dismissed the professor from his chair. He now resumed his errant career, sinking deeper and deeper into debauchery, now saving, now destroying life, by the administration of his potent medicaments. After wandering about in Alsatia, North Germany, Switzerland, and Austria, he was at length seized with a fatal illness in a tavern at Salzburg, and died in the Hospital of St. Sebastian, September 24th, 1541.

Such was the outer life of this extraordinary man, whose

contributions to the theory and practice of medicine, and to other departments of thought and knowledge, I must now briefly notice. As already remarked, the chief practical service of Paracelsus was his application of chemical preparations to medicinal purposes, in lieu of the vegetable decoctions which had previously been in use. Though he repeatedly gives directions for the transmutation of the base into the noble metals, yet in intervals of sobriety or sincerity he recognises the fallacy of this pseudo-science, and expressly states that "the province of alchemy is not to make gold, but to prepare medicines." It is certain that he gave a great impetus to the study of chemistry, and that after his time it became a necessary branch of medical education, and was taught in schools and colleges.* The new force thus brought into play counts for a great deal more than the actual remedies which he has bequeathed to us, though these are of great importance. Among them are preparations of mercury, lead, antimony, sulphur, blue vitriol, iron, and arsenic. His so-called "laudanum" was not opium, but a compound of mercury or antimony with other drugs.

The physiological and pathological theories of Paracelsus were of course crude, and yet showed a certain advance upon his predecessors. All bodies, he taught, including the human frame, consist of three elements—salt, sulphur, and mercury. The just equilibrium of these is health; the excess or defect of any, disease. This seems at first sight something like nonsense; but let us examine a little further. The names of these three elements were not specific, but generic; that is, there were many sulphurs, many salts, many mercuries. Salt represented the principle of fixity, sulphur that of combustibility, and mercury that of volatility. When a substance burns, vapour is given off, a flame is seen, and ashes remain. Nothing could be more natural than to conclude that the substance was made up of three parts,—vapour, flame, and ash,—or, a volatile, a combustible, and a fixed ingredient. Excess of the first in the human body caused insanity; of the second, fever; of the third, stiffness of the joints, and diseases accompanied by the deposition of calculi, which Paracelsus generalised under the name of tartareous disorders, from a supposed analogy with the precipitation of tartar during vinous fermentation. The vegetable and mineral worlds were subject to similar maladies. Gold was the only metal in which the elements were mixed in true

* Alchemy must be regarded not as a mere medley of dreams and fables, but as an early stage in the history of Chemistry, which was no creation either of Boyle or of Lavoisier.

proportion. All others were more or less out of health, and it was theoretically possible that iron and copper, lead and tin, might be "cured" by the alchemist and restored to their pristine Paradisaical purity. Spite of the errors into which he was led, some praise is due to Paracelsus for his apprehension of the fact that vital processes are identical with those which take place in the inanimate world. "*Ignis vita, lignum corpus*"—the body is the wood, the life is the fire—was one of his sayings, to which modern Physiology has given a new import. Much mysticism enfolded this embryonic science. "Digestion," said in substance our professor, "is presided over by a spiritual ruler, who lives in the stomach, and is called the Archæus. If he is ill or out of temper, dyspepsia ensues, so that it is the business of a wise physician to keep on good terms with this gastric potentate, and to study his tastes and necessities. This will in part be accomplished by a diligent study of the stars. Man has an astral as well as a terrestrial body, and all his motions are typified and prefigured in the skies. Human destiny is not *influenced* by celestial phenomena, but runs parallel with them, in a kind of pre-established harmony." According to this theory, indeed, all Nature is literally alive. Even minerals have a feeble animation, for they grow, feed, and excrete. This may have been simply a metaphorical way of describing chemical union and decomposition, which in reality form an essential factor in that sum of forces which we have named Life. Fire, Air, Earth, and Water are deposed from their Aristotelean position as elements, and regarded as conditions of matter, under the names of the Hot, the Cold, the Dry, and the Moist,—the cosmic vitality peculiar to each being allegorised by the invention of appropriate genii, called Salamanders, Sylphs, Gnomes, and Undines. That Paracelsus seriously considered these beings as other than poetic fictions, typifying the universality of life, is scarcely probable, though he doubtless often amused his cynical and world-worn spirit by playing on the credulity of both learned and vulgar. He may, however, have believed to some extent in his doctrine of "signatures." The form of a natural object was supposed to be an index to its properties. For instance, the venation of the leaves of the lesser celandine was compared to the venation of the liver, and this fancied resemblance was taken as a sign that the celandine must be good for jaundice. The bright petals of the little *Euphrasia* seem dotted with tiny violet eyes; therefore the plant was a specific for ophthalmia, on the principle of "*Similia similibus curantur*." It is not necessary to point out the fallacy

of speculations such as these, but it may be well to show *why* they are fallacious. *A priori* absurdity has nothing to do with it. There is nothing especially ridiculous in the proposition that things which have the same internal properties will have a similar external appearance. Nor is it more improbable that a spiritual ruler resides in the stomach than that such a monarch is domiciled in the brain. No; these theories are inadmissible, because they do not fulfil the conditions of a sound scientific hypothesis, which should adequately generalise a whole class of phenomena,—should be able to prove a sound homological relationship with some already demonstrated law or group of facts,—and, finally, should be confirmed by every fresh experiment, accounting for facts discovered subsequently to its formulation, and enabling us to predict the path in which future discoveries are likely to be made. It should explain the unknown by the known, and thus light the way to future knowledge. Here Paracelsus failed; and here, for lack of material, he must have failed, even though his genius had really equalled his self-confidence. Yet he did good, rather than harm, by following that inner light which so often led astray. The scope of his mind may best be estimated by a study of that sublime imagination of Macrocosmos and Microcosmos to which all his leading ideas may be referred. "Man," he might have said, "is the Universe in miniature. The Universe is an enlarged edition of man. The only true science is therefore the science of the human mind and body, and he who has literally obeyed the precept 'Know Thyself' has comprehended the sum of Knowledge. From the rhythmic motion of his own vital organs he can deduce the orbits of the stars; by the stars, again, he can interpret his own fate. From the ill health of his body he may learn the malady which has degraded pure gold to a baser metal, and may even find a cure for both diseases. The flowers of the field are his helpful kindred. 'Herbs gladly heal our flesh, because that they Find their acquaintance there.' * The spirit of the greater world responds to the spirit of the lesser world, and reveals its mysteries with or without the aid of sense. Not every man can hold this communion, which requires a certain corporeal and spiritual purity; but to him who has attained it, the disputations of the schools and the lore of antiquity are alike worthless. He may, indeed, study

* The anachronism of a quotation from George Herbert in an imaginary speech of Paracelsus must be pardoned! It is, of course, the sober truth that both vegetable and mineral medicines "find their acquaintance" in the bodies which they heal.

Nature; but the study of Nature will only be the study of himself."

Such are the outlines of a system based on that idea of correlation between vital and physical forces which fascinated the philosophic intellect long before it could be substantiated on scientific grounds. We find its foreshadowing in the Idealism of Plato. The World, according to him, is a great living Being, fashioned by God after the model of the eternal Universe of Ideas, and endowed with a soul. In this soul all other beings participate, each in his own degree, the fullest measure being granted to man. He, indeed, may become so noble and so pure as to catch glimpses of those immutable Ideas to which his life owes its origin. In these Ideas is contained the explanation and inmost essence of God, Man, and the World, and to find them is to find the only true wisdom. It will be seen that we have here reached the central fire of all mysticism, whether of Greece, India, or modern Christendom; but perhaps the fire may kindle other lamps than that which glows on the altar of the Mystic. We may find a positive basis of scientific fact for what seems at first sight a mere poetic imagination. The details are mere metaphors, but the essential content may be a germ of pure truth.

That in studying external Nature we are really studying modifications of our own consciousness scarcely requires demonstration. Colours and sounds are manufactured by eye and ear, or rather by those cerebral centres with which eye and ear are in nervous continuity; and the ideas of colour and sound cannot reside elsewhere than in the brain which gave birth to the corresponding sensations. But eye, ear, and brain are not separate from the so-called "external" world. They are constantly exchanging with their environment matter for matter, and force for force. They submit to the same physical laws which reign over inanimate Nature. Gravitation, heat, light, electricity, are all at work; the laws of optics or acoustics apply just as much to the eye as to the spectacles, to the ear as to the telephone. Yet more—the essential phenomena of human nutrition and development are repeated in all other animals, and even in plants. From the lowest much may be learnt which holds good of the highest. Take the *Amœba*. Is it not an *exact* homologue of the white blood-corpuscle in man? Both are contractile, irritable, automatic. Both can feed, breathe, and reproduce their kind. Indeed the relation of the blood-corpuscle, or of any other living cell, to man, well typifies man's relation to the Macrocosm. His body is

the world where myriads of tiny individuals are born, live, move about, perform their various functions, and die. May he not truly call himself a Microcosm? Even the doctrine of Reminiscence or Intuition must find a place, though a humbler one than that assigned it by Plato and Paracelsus. It is what we name Instinct or Hereditary Aptitude, and of course plays a great part in all theories of Evolution. Every one will now-a-days admit that the mind is not a mere sheet of white paper, on which the external world writes. It is rather a mould, into which the external world is poured. The young of all animals—of man among the rest—come into existence with certain organic predispositions, and can perform certain actions without being taught, and others with very little teaching. The mind grows in that direction in which the organism is bent. Even abstract ideas, though not actually innate, can be implanted in some constitutions far more readily than in others; they come more naturally, as we say, to the "supreme Caucasian mind" than to the African or Red Indian. Faculties are innate, though ideas are not; and the seemingly instinctive grasp of truth, which is the privilege of a few, may not unfitly be allegorised as a direct communion between the human soul and the Anima Mundi.

I have now completed my sketch of the merits and demerits of Paracelsus, who gave a temporary incarnation to thoughts which had descended from antiquity, and which have since roamed about under various shapes and titles till they have at last transmigrated into the conceptions of modern science. The special form with which he endued them has now only an historical intereest; yet his labour was not lost. Facts must be accumulated; but the human spirit cannot live on facts alone. If there are not enough to constitute the basis of a scientific theory, it demands, and will have, an unscientific one. And those who supply its needs help to maintain its vitality. But directly the scientific *rationale* becomes possible, it also becomes imperative: and he who still seeks to preserve the old unscientific dogma is a foe instead of a friend,—a poisoner instead of an almoner; for bread he gives a stone,—for an egg he offers a scorpion.

II. THE BIRTH AND EVOLUTION OF THE SOLAR SYSTEM.

TRANSLATED FROM PAGES 113 TO 132 OF "GEDANKEN" (1857, Philadelphia, published by Thomas).

By O. REICHENBACH.

(Concluded from page 152.)

THE relations of the exterior system are inverse and corresponding at the same time. It separates by staying behind. It is the real central mass, the perihelion, Jupiter which projects. The largest concentration, from which the others develop themselves centrifugally, falls beyond the point of gravitation, which is at $7808\,r$ solar distance.

It so corresponds with regard to mass planet A to the Earth, Neptune to Venus; in reference to distance from point of gravitation it is the reverse. It corresponds in such twofold manner, but again reversed—Uranus, the projection of A, to Mercury; planet B, the projection of Neptune, to Mars. We so have, as distances of those planets from their point of gravitation,—

A ... ... $7808\,r \times 1{\cdot}107 \times 1{\cdot}05 = 9050\,r.$

Neptune—

$$\frac{7808\,r}{1{\cdot}212} = 6447\,r.$$

Uranus—

$$\frac{7808\,r \times 1{\cdot}05}{1{\cdot}72 \times 1{\cdot}107} = 4012\,r.$$

B ... ... $7808\,r \times 1{\cdot}72 \times 1{\cdot}22 = 16360.$

We know how the mass is distributed amongst the three systems, and amongst the two central parts; it remains to find its distribution in the secondary systems.

The mass of A is of that of Jupiter—

$$\frac{1}{8{\cdot}8 \times \left(\frac{1{\cdot}22}{1{\cdot}025}\right)^2} = \frac{1}{12{,}911} \text{ of the solar mass.}$$

Neptune is—

$$\frac{1}{12{,}911 \times \left(\frac{1{\cdot}22}{1{\cdot}1 \times 1{\cdot}05}\right)^2} = \frac{1}{14{,}202}.$$

Uranus projected by A—

$$\frac{1}{12{,}911 \times (1{\cdot}22 \times 1{\cdot}1)^2 \times 1{\cdot}05^2} = \frac{1}{24{,}918}.$$

B projected by Neptune—

$$\frac{1}{14{,}202 \times \left(\frac{1{\cdot}22 \times 1{\cdot}107}{1{\cdot}05}\right)^2} = \frac{1}{22{,}729}.$$

Venus is of the mass of Saturn—

$\frac{1}{77 \times 1{\cdot}21^2 \times 1{\cdot}025^2}$, or $\frac{1}{413{,}800}$ of the solar mass.

The Earth—

$\frac{1 \times \left(\frac{1{\cdot}22}{1{\cdot}107 \times 1{\cdot}025}\right)^2}{415{,}800} = \frac{1}{359{,}511}$ of the solar mass without the moon.

Mars projected by Venus—

$$\frac{1 \times 1{\cdot}22^2 \times 1{\cdot}05^2}{415{,}800 \times 8{\cdot}8} = \frac{1}{2{,}345{,}112}.$$

Mercury projected by the Earth—

$$\frac{1}{359{,}511 \times 8{\cdot}8 \times 1{\cdot}22^2 \times 1{\cdot}025^2} = \frac{1}{4{,}943{,}275}.$$

Astronomy gives these masses—

Mercury	$\frac{1}{4{,}865{,}751}$.	Venus	$\frac{1}{401{,}839}$.
Earth	$\frac{1}{359{,}511}$.	Uranus	$\frac{1}{24{,}605}$.
Neptune	$\frac{1}{14{,}446}$.	Earth with Moon	$\frac{1}{355{,}499}$.

The differences with my numbers are insignificant. The only more considerable is with Mars, yet Astronomy does not pretend to give the masses of the moonless planets with precision: I also do not insist that the mass I give for Mars is exact. There is a tertiary perturbation, considerable in

proportion to the system—our Moon; planet A may show something similar. The Moon as mass does not belong to the Earth: the quantity of the latter was too great; it threw off the surplus which did not reach its aim—Mars. Mercury, the co-planet of the Earth, thus probably also obtained more mass; 1-14th of the mass of our moon it ought to be.

This disturbance, perceptible with Saturn, is probably connected with the asteroids. The mass of them has thus to be equal to—

$$\frac{8{\cdot}8 \times 1{\cdot}22}{680^3} = \frac{1}{29{,}500{,}000}$$

of that of the Sun.

The mean distance of Flora is $471\,r$; of Hygiea, $671\,r$.

$$680\,r - (77{\cdot}3\,r \times 2{\cdot}96) = 456\,r = 397\,r \times \frac{1{\cdot}22}{1{\cdot}05}.$$

The former is in the mean little beyond that region, in which the inner projection might have seized it; the latter still inside $680\,r$, not far from the original central planetary mass. Both are in that region which appears like empty at the head of the comet between nucleus and envelope. Should not a number of such asteroids, 2·76 times less in mass, exist between $3676\,r$ and $3820\,r$ distance?

The mass of the Moon is 1-87 of that of the Earth; it is 1-31,282,500 of the Sun, if we add the 1-14·87 which the mass of Mercury appeared larger than Enke's calculation made it out; the quantity becomes 1-29,500,000 of the solar mass: others give the mass of the Moon 1-81 of that of the Earth, which at once gives 1-29,500,000 of that of the Sun. The diameter of our Moon is 454 geographical miles; that of the largest of the planetoids is believed not to exceed 145 miles: it would require twenty-eight such bodies, of equal density with our Moon, to make up the latter.

I made the mass of Mars 1-2,345,112 of the Sun. Astronomy gives it 1-2,680,337: if we deduct from the former figure the mass of our Moon, 1-29,500,000, and the plus of Mercury (or possibly of a lunar system), we get about the second figure (but even the mass of the planetoids may be considered a reduction of the mass of Mars).

I return from these problematic tertiary relations to the secondary. We found the density of the central parts to agree with observation; the latter gives the densities:—that of the earth, 1·000; the Sun, 0·252; Mercury, 1·234;

Mars, 0·698; Venus, 0·940; Jupiter, 0·243; Saturn, 0·140; Uranus, 0·178; Neptune, 0·238. It is difficult to account for laws of density; we entertain a general idea, we see if the results correspond, and we are satisfied when we reason logically. Density must depend on the relations of the projecting masses, and on the pressure to which the projected mass is exposed at its ultimate position. In the case of the two central planets the relation was less complicated. The mass of the secondary systems is projected between its central part and the solar influence—here repulsive, there attractive. We seek at first the imaginary density, the point of gravitation; from this we infer the density of the concentrations. The exterior system is projected by the smaller mass between the larger mass and the Sun.

We had the density of the primary point of gravitation equal to that of the Sun, equal 1. Matter projected by Saturn arrives here between a mass 3·347 times greater and the Sun, and thus becomes 3·347 times more dense than 1 (the Sun): but Saturn has an elongation of 1·025; matter arrives consequently with a retardation of 1·025; density so becomes—

$$\frac{3\cdot347}{1\cdot025^2} = \frac{3\cdot347}{1\cdot05},$$

$= 3\cdot2$ more than that of the Sun. The greater, then, the elongations of the concentrations, so much more they are pressed against the more powerful limiting bodies, so much denser they become; so are more dense than the Sun.

Venus ... $3\cdot2 \times 1\cdot107 \times 1\cdot05$. Mars ... $\frac{3\cdot2}{1\cdot107 \times 1\cdot05}$.

Earth ... $3\cdot2 \times 1\cdot22$. Mercury $3\cdot2 \times 1\cdot22^2$.

Comparing these densities with those of observation, the density of the Earth is 1-1·012 less, or that of the Sun 0·255 of that of the Earth; Jupiter and Saturn agree with observation; Venus and Mercury are slightly less than the figures of observation. A more considerable difference exists with regard to Mars. The exterior system is projected by the larger mass, by the recalling distant attraction of the Sun and the smaller less dense mass of the central aphelion (Saturn). It is the central mass which projects; the density would so be equal to 1, to that of the Sun; but as the projecting mass has an elongation of 1·05 towards the Sun, the propelled mass arrives with a $1\cdot05^2 = 1\cdot07$ times greater velocity, density becomes 1·107 more than that of

the sun. The concentrations are here by their elongations pressed against the re-attracting yet decreasing force of the Sun, and against the central aphelion; their density decreases with elongation.

Point of gravitation 1·107 more dense than the sun.

$$\text{A} \ldots \ldots \frac{1\cdot107}{1\cdot102 \times 1\cdot05} \text{ of the density of the sun.}$$

$$\text{Uranus} \ldots \ldots \frac{1\cdot107}{(1\cdot107 \times 1\cdot05)^3}.$$

$$\text{Neptune} \ldots \ldots \frac{1\cdot107}{1\cdot22}. \qquad \text{B} \ldots \ldots \frac{1\cdot107}{1\cdot22^2}.$$

The densities are therefore—that of the Earth, 1; the Sun, 0·255; Mercury, 1·22; Mars, 0·69; Saturn, 0·141; Neptune, 0·232; Venus, 0·930; Jupiter, 0·243; Uranus, 0·200; A, 0·242; B, 0·187.

Proceeding to the velocities of rotation, I begin again with the inner system. Rotation of the point of gravitation of the central mass was 68·5 times more rapid than that of the Sun. As the mass now proceeds from the aphelion it moves 2·95 times more slowly, but by the elongation it experiences 1·21 more rapidly. The point of gravitation at 176 from the Sun would therefore have a rotation—

$$\frac{68\cdot5 \times 1\cdot22}{2\cdot96} = 28\cdot1$$

more rapid than that of the Sun.

The velocity increases inversely as the square of the single elongations increases. We have for—

$$\text{Venus } \frac{28\cdot1}{\sqrt{(1\cdot10 \times 1\cdot025)}} = 26\cdot31; \quad \text{Earth } \frac{28\cdot1}{\sqrt{1\cdot22}} = 25\cdot38;$$

$$\text{Mars } \frac{28\cdot1}{\sqrt{(1\cdot10 \times 1\cdot025)}} = 24\cdot63; \quad \text{Mercury } \frac{28\cdot1}{1\cdot22}$$

days during one revolution of the Sun.

A difference there is with Mercury, whose day is 26 h. 26 m., whereas observation has adopted 24 h. 5 m.

The separation of the inner system resulted by a more rapid transport; it may be considered as resulting from a shock, the line of planetary development experienced between G and γ in the sense of the whole transportation (designating

the central point of gravitation by G, the interior one by γ, the exterior one by g). The largest masses of both systems, the central and the inner one, are between G and γ; thus nothing is altered in the sense of rotation. It is otherwise with the exterior system, separated by remaining behind in revolution, whose outward larger portion moves more slowly than the inner one, the former being projected by the larger Jupiter and re-attracted by the smaller Saturn. The separation resembles a shock still in the sense of translation between G and g, but between smaller masses matter will revolve with a velocity corresponding to its position, but in an opposite sense; A will comparatively stay behind in elongation (and we may ask if the result should not be a double undulatory rotation, an access to rotate forward and a real backward rotation ?)*

We thus have absolute forward rotation of g in the sense of general transport—

$$\frac{68{\cdot}5}{1{\cdot}72 \times 1{\cdot}102} = 36.$$

A, $36\sqrt{(1{\cdot}102 \times 1{\cdot}05)} = 39$; Neptune, $36\sqrt{(1{\cdot}22)} = 40$;
Uranus, $36 \times (1{\cdot}1 \times 1{\cdot}05) = 41{\cdot}6$; B, $36 \times 1{\cdot}22 = 43{\cdot}6$

revolutions during one revolution of the Sun.

Doubts of the probability of this development may give way before an examination of the excentricities of orbits. They are—

Mercury 0·20561	Jupiter 0·048162	Uranus 0·0466108
Venus... 0·00686	Saturn 0·056150	Neptune 0·0087194
Earth... 0·016729		A... ... 0·0038894
Mars ... 0·093216		B... ... 0·11366

Whoever recollects how these bodies formed in groups will recognise the relation with excentricities, and how the points of gravitation and mean distances of planets are quantities round which they unroll centrifugally and roll up centripetally.

We have for the central poles—Jupiter, 0·04816; Saturn, 0·05615. We have—

$$\frac{0{\cdot}05615}{0{\cdot}04815} = \frac{\left(\frac{1{\cdot}22}{1{\cdot}025} + 1{\cdot}107 \times 1{\cdot}05\right)}{2} = 1{\cdot}167,$$

* This view requires correction.—Reich.

And—

$$\frac{1\cdot167}{2}=\frac{1}{1\cdot72}.$$

$1169\cdot6\,r-1116\cdot6\,r=53\,r$ as elongation of Jupiter.

$$\frac{53\,r}{1116\cdot6\,r}=0\cdot0479=\text{excentricity of Jupiter.}$$

Saturn, $2047\,r$ as distance, $41\,r$ as elongation, $2\cdot96$ as development of aphelion.

$$\frac{41\,r\times2\cdot96}{2047\,r}=0\cdot0572=\text{excentricity of Saturn.}$$

We pass on to the interior system:—

$\frac{\text{Earth } 0\cdot01672}{\text{Venus } 0\cdot00686}=2\cdot447$, and $\frac{2\cdot447}{2}=1\cdot223$ aphelion direct.

$\frac{\text{Mercury } 0\cdot20561}{\text{Mars } \ldots\ 0\cdot9321}=2\cdot205$, and $\frac{2\cdot205}{2}=1\cdot103$ perihelion indirect.

Adding the excentricities of the corresponding concentrations we have—

Mars	0·0932
Venus	0·0068
	0·1000

Div. by $2\times1\cdot025$ ...)0·048 = excentricity of Jupiter—antipole.

Earth	0·0167
Mercury	0·2051
	0·2218

Div. by $2\cdot172\times1\cdot22$)0·0559 = excentricity of Saturn—synpole.

The excentricities of projections derive from their projections:—

For Mars.—Excentricity of Venus $0\cdot00686\times8.8\times1\cdot22^2=$ $=0\cdot0934$, excentricity of Mars.

For Mercury.—Excentricity of Earth $0\cdot0168\times8\cdot8\times$ $\times(1\cdot107\times1\cdot025)^2=0\cdot200$, excentricity of Mercury.

We have, for the exterior system, distance of A 9050 r, and—

$$\frac{77{\cdot}3}{9050 \times 1{\cdot}72 \times 1{\cdot}107 \times 1{\cdot}05} = 0{\cdot}00427, \text{ excentricity of A.}$$

Distance of Neptune, 6447 r:—

$$\frac{77{\cdot}3}{6447 \times (1{\cdot}107 \times 1{\cdot}22)} = 0{\cdot}0087, \text{ excentricity of Neptune.}$$

Uranus, excentricity of A $0{\cdot}00427 \times 8{\cdot}8 \times (1{\cdot}107 \times 1{\cdot}025)^2 =$
$= 0{\cdot}0466$, excentricity of Uranus.

B, excentricity of Neptune $0{\cdot}0087 \times 8{\cdot}8 \times 1{\cdot}22^2 = 0{\cdot}1136$, excentricity of B.

$$\frac{\text{Excent. of B...} \quad \ldots \quad 0{\cdot}1136}{\text{Excent. of Uranus.} \quad 0{\cdot}0466} = 2{\cdot}44, \text{ and } \frac{2{\cdot}44}{2} = 1{\cdot}22.$$

$$\frac{\text{Excent. of Neptune} \quad 0{\cdot}0087}{\text{Excent. of A...} \quad \ldots \quad 0{\cdot}0042} = 2{\cdot}10, \text{ and } \frac{2{\cdot}10}{2} = 1{\cdot}05.$$

Excent. of A... ... 0·00427
Excent. of Uranus. 0·04661

2) 0·05088

0·02544

0·02544 × 1·72 × 1·107 = 0·048, excent. of Jupiter.

Excent. of Neptune 0·0087
Excent. of B... ... 0·1136

2 × 1·05) 0·058 = excentricity of Saturn.

The excentricity of Jupiter now increases, of Saturn decreases, of Venus and Earth decreases, of Mercury and Mars increases, of Uranus and B decreases, of Neptune and A increases.

In the original, and in "Two Planets" I then go on to the other elements, the actual position of the latter planets included; to the lunar systems, where some revision is required; and to the own motion of the solar system, corrected in "Two Planets."

Having, since the publication of the above, shown the connection of planetary excentricities with the proportions of their solid and fluid masses, and the general intimate

reciprocity of all solar with all planetary phenomena, the interchange of matter between the bodies of the system cannot be questioned; and I may some day ask your permission, Mr. Editor, to speak about *its manner* in the "Journal of Science."

III. CHARLES DARWIN: HIS BIOGRAPHERS AND HIS TRADUCER.*

THE discussion of these brief but important and appreciative sketches of Charles Darwin, as a geologist, a botanist, a zoologist, a psychologist, and as a man, is rendered the more seasonable by a singular incident. A voice has been raised against the great naturalist from an unexpected quarter. One Henry G. Atkinson has seen fit to write and to publish these words:—"Carlyle says truly, 'A good sort of man is this Darwin, and well-meaning, but with very little intellect.'" (!) Again:—"All agree that his [Darwin's] introducing a Creator to breathe the breath of life into the first form was mere subterfuge. Carlyle says that the three Darwins—grandfather, father, and Charles—were Atheists; and as he knew them all, his statement may be taken as thoroughly reliable."

To adjudicate on the religious orthodoxy or heterodoxy of scientific men is certainly not, under any ordinary circumstances, our duty; but the imputation of Atheism is here mixed up with a charge of dishonesty, and with such an amazingly impertinent attempt to disparage Darwin intellectually, that we feel bound to exhibit the accuser and his witness in their true colours.

We ask, firstly, Did Carlyle really and truly commit himself to the utterances which are here ascribed to him, and especially did he lay claim to a personal knowledge of the three Darwins? If so, he was guilty of a grave departure from the truth. It is known that he was born in 1795, at Ecclefechan, where he spent his childhood. It is equally

* Charles Darwin. Memorial Notices reprinted from Nature. London: Macmillan and Co.

well known that Erasmus Darwin died in 1802, at Litchfield. There is, as a correspondent tells us, no tittle of evidence that the two ever came within a hundred miles of each other; and there is further no shadow of likelihood that, had they met, the old physician would have expounded his theological views to a peasant child under seven years of age, or that the latter, had he done so, would have attended to or understood the lecture. If Carlyle cannot claim a personal knowledge of the elder Darwin, but judged merely from common report or from published documents, his statement is, as we shall see, *not* "thoroughly reliable," or, in English, trustworthy. It is, however, conjectured by some that the charges brought against the Darwins may be traced to an apocryphal or pseudo-Carlylean letter which appeared in a Scottish provincial journal, and which seems to have been widely reproduced as if genuine. Be this as it may, Mr. Henry G. Atkinson has shown culpable levity and indiscretion in adopting and repeating such assertions without due inquiry into their evidences. Had he examined the works of Erasmus Darwin he would have discovered—*e.g.*, in the "Phytologia," written only three years before the author's death—ample disproof of the charge of Atheism. This book bears as a motto on its title-page the following line from the "Ordo Naturæ" of Linné:—"*Suadent hæc Creatoris leges a simplicibus ad composita.*" On reading through the work Mr. Atkinson would have found not merely a total absence of any denial of the existence of God, either explicit or by inuendo, but he could scarcely have overlooked such passages as the following:—"Great God of Justice! grant that it [sugar] may soon be cultivated only by the hands of freedom, and may thence give happiness to the labourer as well as to the merchant and the consumer" (p. 77). Or—"Surely this must be called a wise provision of the Author of Nature, as by these means innumerable animals enjoy life and pleasure without producing pain to others. There is another source of nutriment provided for young animals which still further evinces the benevolence of the Author of Nature, and that is the milk furnished by the mother to her offspring: by this beautiful contrivance the mother acquires pleasure in parting with a nutritious fluid, and the offspring in receiving it" (p. 82). Or the following:—"Thirdly, there should be no burial-places in churches or in churchyards, where the monuments of departed sinners should shoulder God's altar, pollute His holy places with dead men's bones, and produce by putrid exhalations contagious diseases among those who frequent His worship" (p. 242). Or, lastly:—

"We acquire the sublime and interesting idea that all the calcareous mountains of the world are monuments of the past felicity of organised Nature, and consequently of the benevolence of the Deity" (p. 560). Whether these passages, to which many more might easily be added from the other works of Erasmus, do not outweigh the statement of Carlyle, even if not a forgery, we cheerfully leave to the judgment of our readers.

Turn we next to Dr. Robert Darwin, the father of Charles. This gentleman was admittedly for many years the contemporary of Carlyle. It is perfectly possible that they may have met, and even—though we have no evidence to that effect—that some degree of intimacy may have existed between them. But there is no collateral evidence in support of the alleged Atheism of Robert Darwin. The mere word of Thomas Carlyle can count for very little, for though he might not consciously and knowingly promulgate falsehood he was essentially a self-deceiver. Though far from orthodox himself, and at one time regarded by the religious world as an arch-infidel, he had an intense hatred of Atheism and "Materialism," and was apt to suspect their presence where non-existent. In opposition to his alleged testimony, it is a known fact that Robert Darwin was a member of a Unitarian congregation at Shrewsbury. He further, as may be learnt from the little work before us, destined his illustrious son for the Church. With this view Charles was sent to the University of Cambridge, where he graduated as B.A. in 1831, and as M.A. in 1837. Nay, even in 1838, when he was about setting out on his memorable voyage, his father hesitated, fearing lest it might "unsettle him for the Church." We can scarcely imagine an avowed Atheist seeking, during the term of more than seven years, to devote his son to a clerical career. Here also, as in the case of Erasmus, we are forced to conclude that Carlyle's evidence, as given by Mr. H. G. Atkinson, is, if authentic, untrustworthy.

Charles Darwin and Thomas Carlyle were of course contemporaries for upwards of threescore years. Their respective places of abode were, since 1842, not very far apart. The "philosopher of flatulence and acid indigestion," as Carlyle has been happily named, was well acquainted with a brother of Darwin's, and may consequently have met with the great "Reformator" of Natural History. But between two characters of such world-wide difference there could be little sympathy. Hence, without such full proof as would satisfy a court of justice, we must decline to believe that Darwin would make a confidant of Carlyle.

We must protest against the assertion—"All agree that his introducing a Creator to breathe the breath of life into the first form was mere subterfuge." All do not so agree! Few of those who have studied Darwin fairly and faithfully in his works—fewer still of the more fortunate circle who have enjoyed his personal intimacy—will be ready to accuse him of a "subterfuge." A chivalrous devotion to truth, quite independent of its possible bearings upon his theories, his reputation, or his interests, was one of the most strongly marked features of his character. Whether in the latter part of his life he adopted atheistic opinions—as is asserted by Prof. Haeckel, Dr. Aveling, and others both among his admirers and his enemies—is not here the question. But that he wrote the memorable concluding passage of the "Origin of Species" in good faith we shall uphold until we meet with very decisive evidence to the contrary.

The joint verdict of Thomas Carlyle and of Mr. Henry George Atkinson, that Darwin was a man of "very little intellect," is too ridiculous for formal examination, and will be endorsed only by those who cherish the well-known aspiration of Dogberry. To give a new impulse and a new direction to every department of Organic Science, to breathe into research a new spirit, a veritable breath of life, must be recognised as a very different task from writing essays and histories, in however striking or grotesque language.

It is common for the religious world to infer that every atheist, everyone who can be included under the ill-defined classes of "infidels" and "skeptics," must of necessity be Evolutionists and admirers of Darwin. Let them remember that Auguste Comte, and his followers the "Positivists," with perhaps the single exception of the late George Henry Lewes, are decidedly hostile to Evolution. And here we find a most contemptuous estimate of Darwin formed by such heresiarchs as Carlyle and Mr. H. G. Atkinson.

But enough of these worthies: let us turn to a more pleasing task, and examine the judgment pronounced upon our great naturalist by competent authorities—his friends and fellow-workers.

Prof. Huxley, in his "Introductory Notice," appreciative as it is, and breathing a noble affection for the Departed, contains one unfortunate passage to the effect that "One could not converse with Darwin without being reminded of Socrates." Perhaps had Prof. Huxley ever conversed with Socrates he would not have ventured on this comparison. The vast difference between the two was explained in the "Journal of Science" for June last.

We come to the sketch of Darwin's character and life as furnished by Mr. G. J. Romanes. Here we find a full and just tribute paid at once to the wonderful intellect, and, what the writer ranks as "no less great, or even greater," the character of the man. He proclaims it as his first duty "to render some idea, not of what Darwin did, but of what he was." It is impossible for us to reproduce the portrait of Darwin as here drawn with equal truth and beauty. We read that "in him the man of Science and the philosopher were subordinate to the gentleman. His courteous consideration of others, which went far beyond anything that the ordinary usages of society require, was similarly prompted by his mere spontaneous instinct of benevolence. . . . No man ever passed away leaving behind him a greater void of enmity, or a depth of adoring friendship more profound."

All this is true, and we are happy to find it thus distinctly recorded. But wherefore? For in one sense it must be admitted, as Buckle insisted, that what a man *is* is of far less general and permanent importance than what he *does*. Character is soon forgotten; but performances, works, achievements, whether in the inner or the outer sphere, are the property of the world for ever. But the beauty and the grandeur of Darwin's character, and the happiness of his life, are precious as affording the best answer to that new school of Ethicists who pronounce Science hostile to happiness and morality. Such persons will find that, whilst in Darwin incessant intellectual activity crowded out moral evil and superseded the necessity for a "struggle with temptation," he did not "freeze and harden," and his "natural affections" did not "vanish."

Darwin was first sent, in 1825, to the University of Edinburgh, then in the zenith of its reputation as a medical school. Here, it appears, he studied under Prof. Jameson, F.R.S. L. and E., F.L.S., F.G.S., M.R.I.A., F.A.S., F.W.S., and F.H.S. (Edinburgh), Regius Professor of Natural History, Lecturer on Mineralogy and Keeper of the Museum in the University of Edinburgh, and Editor of the "Edinburgh New Philosophical Journal." Under this gentleman of forty-three titles, who was severely but not unjustly scourged by Waterton, Darwin "does not seem to have profited at all by whatever instruction he received; for not only did it fail to awaken in him any special love for Natural History, but even seems to have had the contrary effect." This was, for him and for Science, a most fortunate escape. Had he, at the plastic age of seventeen or eighteen, attached himself to Jameson, he might have become a normal high

and dry "Brodgelehrter," zealously discussing "good" and "bad" species and studying Biology from ill-stuffed specimens, but never the great re-creator of Natural History. To awaken the sacred thirst for truth in the mind of young Darwin was reserved for a man far greater than Jameson, though less pretentious—Prof. Henslow, of Cambridge.

We are here naturally led to the question of precocity. Did Darwin, like so many other naturalists, show in boyhood a disposition to collect and study insects, plants, or other specimens? Here Mr. Romanes gives an uncertain sound. He writes:—"As he [Darwin] used himself to say before he knew Prof. Henslow, the only objects of Natural History for which he cared were foxes and partridges. But owing to the impulse which he derived from the field excursions of the Henslow class he became while at Cambridge an ardent collector, especially in the region of Entomology." Elsewhere, however, Mr. Romanes quotes a letter of Darwin's, in which the latter says—"I went to Cambridge early in the year 1828, and soon became acquainted, through some of my brother entomologists, with Prof. Henslow; for all who cared for any branch of Natural History were equally encouraged by him." Here, then, we have distinct evidence that Darwin was already an entomologist prior to his acquaintance with Prof. Henslow. But we need merely read the whole of the letter referred to in order to find that Prof. Henslow exerted upon him a most powerful and salutary influence. The friendship which sprung up between them was indeed broken off only by death. It was upon Henslow's advice that he seized the opportunity of joining the surveying voyage of the *Beagle*.

Three perils were thus overpast. He had escaped becoming a routine naturalist of the Old School, a practising physician, or a country clergyman, carrying on the study of Entomology as a recreation. Another danger which he would have encountered in our days was non-existent. He never "passed" or "prepared for" an examination in any department of Natural History. He learned simply in order to know, and the result was great accordingly.

The account of Darwin's work in Geology—or, as it would perhaps be better expressed, his influence upon Geology—is furnished by no less an authority than the Director-General of the Geological Survey, Dr. Archibald Geikie, F.R.S. He lays emphasis on the fact that Darwin's discoveries, f fatal to catastrophism, are far from supporting uniformitarianism. "That the present must be taken as a guide to the past has been more fearlessly asserted than ever. And yet

it has been recognised that the present differs widely from the past; that there has been a progress everywhere; that Evolution, and not Uniformity, has been the law by which geological evidence has been governed." If not the first to recognise the incompleteness of the geological record, he first convinced the world of its necessarily fragmentary character. He showed the fallacious nature of the assumption that the stages of the record "were sharply marked off by the first appearance and final disappearance of certain species." He first suggested that the geographical distribution of animals and plants throws a light on the changes of land and sea. How fruitful this hint has proved is universally known.

As a botanist Darwin's work is estimated by Mr. W. T. Dyer, F.R.S., Assistant-Director of the Kew Gardens. Here, too, the indirect effect of the Doctrine of Development must be pronounced more weighty than the direct results of Darwin's own contributions. But though he always disclaimed the right to be regarded as a botanical specialist, Mr. Dyer rightly says that each of his botanical investigations, taken on its own merits, would alone have made the reputation of any ordinary botanist. He detected, analysed, and interpreted phenomena which the professed botanical world had for the most part overlooked. We need merely refer to his studies on circumnutation, on the fructification of orchids, on hybridism, and on the distribution of plants. Particular attention is called here to the warm enthusiasm, the passionate joy in Nature which he shared with Linnæus and Humboldt, and which he complains is wanting in the narrower being of some of our more recent naturalists.

Darwin's greatness is, however, most fully shown in his work on *Z*oology. Mr. Romanes well says "He was able to appreciate and successfully to cultivate every department of biological research,—whether morphological, physiological, systematic, descriptive, or statistical,—and at the same time to rise above the *minutiæ* of these various branches to take those commanding views of the whole range of Nature and natural science which have produced so enormous a change in our means of knowledge and our modes of thought. No labourer in the field of Science has ever plodded more patiently through masses of small detail; no master-mind on the highest elevation of philosophy has ever grasped more world-transforming truth."

Darwin's elaborate monograph on the *Cirripedia* is referred to as proof that had he confined himself to morphology he

would have been unsurpassed in that speciality, and as proof that he was not the amateur which certain French official *savans* rashly pronounced him. But Mr. Romanes adds that it would have been a calamity in the history of our race if Charles Darwin had been tempted to become a comparative anatomist. Such work he did well to leave to men who, though great, are still far his inferiors.

Mr. Romanes sums up this part of the subject by quoting the conclusion of the "Origin of Species," which does not seem, to him, a subterfuge.

The last section of the little work, from the same pen, views Darwin as a psychologist. In this department his direct contributions are limited to one chapter in the "Origin of Species," three chapters in the "Descent of Man," and a short paper on the development of infantile intelligence. Moreover, he was indifferent to the verbal subtleties of the official psychologists who approach this subject from a metaphysical side. Hence by them he was regarded at first as a presumptuous outsider. Nevertheless he shook their science to its base, and left them humbler, and we would fain hope wiser, men.

In drawing to a close Mr. Romanes expresses a "regret that the ill health which led to his seclusion prevented the extraordinary beauty of his character from being more generally known by personal intercourse." We regret that he was, ever since his voyage in the *Beagle*, a sufferer. At the same time we cannot help suspecting that these very sufferings and the seclusion which they occasioned were not unmixed evils. A wider range of personal acquaintance might have distracted him from his grand life-task, and perhaps have even led him to waste his time and his energies in work for which inferior minds are quite competent.

What is wanting in the work before us is a general estimate of Darwin's influence, not in this or the other branch of Science, but upon the whole horizon of human thought. This task, perhaps, may advantageously be postponed till the seeds sown by him and his disciples shall have sprung up and borne fruit.

IV. AN UNWELCOME TRUTH.

By An Old Technologist.

NOT very long ago the farmer was told by eminent agricultural chemists that he ought to know at all times what quantity of plant-food existed in his fields, so that he might at once see how much and what kind of manure need be added to meet the requirements of any crop intended to be planted. It was laid down that if the soils were carefully analysed at the outset, and if the weight and composition of the manures employed were added, and, on the other hand, the weight and composition of the crops taken from the fields year by year, a balance might be struck at the end of any season, showing how much combined nitrogen, phosphoric acid, potash, &c., remained on the soil. The whole affair had about it an appearance of beautiful simplicity. It was of course admitted that fertilising matters present in a soluble condition might be washed away in the drainage in a wet season. No one would have attempted to deny that ammonia, if present in the free state, or if combined with carbonic acid, must to some extent escape into the air. And it was also no secret that not all the mineral plant-food found in the soil, on chemical analysis, was present in an available condition. But the extent and importance of these drawbacks have only quite recently been placed before all concerned in a distinct light.

It is only just to say that the results reached are unpleasant and unwelcome. Still nothing can be gained by ignoring facts, especially when they affect the entire population of all civilised countries.

It has been established, by the researches of M. P. P. Dehérain, that—at least as far as combined nitrogen is concerned—the amount of plant-food removed from arable land by the crops is neither the whole, nor in many cases the greater part of the yearly loss. Given the original analysis of the soil, the weight and analysis of the manures added and of the harvests taken away, we cannot find the amount of plant-food remaining. An important factor has been left out of the account.

M. Dehérain began, in the year 1875, a series of experiments at the Agricultural Station at Grignon. The soil of

a field was, to begin with, thoroughly analysed. The field was then divided into plots; certain of these were plentifully dressed with farmyard manure, others with sulphate of ammonia or soda saltpetre, whilst others, again, remained unmanured. All these three kinds of plots were planted with maize and potatoes for seven years in succession, and at the end of the last season the results were made known. In what state was the soil of these experimental plots?

Had this question been submitted to an agricultural chemist of the year 1850, he would doubtless have replied that the unmanured portions of land would be found decidedly impoverished, whilst the manured portions would—at least as far as combined nitrogen is concerned—have become no poorer, or, if the supply had been sufficiently plentiful, might even have been enriched. As early as 1878 it was found that the loss to the soil was very much greater than would follow from the combined nitrogen carried away in the crops. Not merely the unmanured plots, but those which had received sulphate of ammonia and soda saltpetre were found distinctly impoverished. Those plots, on the other hand, which had been dressed with farmyard manure had grown somewhat richer. But it must be distinctly understood that they also had not retained the entire supply of nitrogen over and above that consumed by the crop. Hence it would appear that if nitrogen is supplied to the land in a readily soluble form, as in the salts above mentioned, a very considerable proportion is lost. It dissolves in the rain-water, soaks down into the drains, and passes away into the rivers.

But M. Dehérain draws from his experiments a further conclusion—the more plentiful the manuring the greater is the loss. This appears from the fact that from 1878 to 1881 the cultivation of maize was continued, but wheat was grown instead of potatoes, and the supply of manures was brought to an end. The crops were weighed yearly as before, and the soil was analysed in the year 1881. A loss of combined nitrogen was still apparent, greater in quantity than that consumed by and carried off in the crops. But the yearly loss was smaller than it had been during the years of copious manuring.

A third point which became apparent, though perfectly in accordance with known chemical laws, is equally unwelcome. These losses of nitrogen ceased when the land was no longer subject to yearly cultivation, but was converted into an artificial meadow. From 1875 to 1879 a series of plots had been yearly planted with beets, and in the last year the soil, on analysis, was found to be impoverished to

a noteworthy degree. Then sainfoin was substituted for the beets, and, although no manure was given and three good crops were taken off, the soil was found in 1881 to be not only not impoverished, but slightly enriched.

M. Dehérain infers that the method of cultivation adopted has a greater influence upon the richness of the soil than the manure supplied and the crops taken away. The experiments conducted at Grignon lead to this significant result —arable land in constant, regular cultivation, cannot be enriched by large applications of soluble manures. The improvement which is produced by farmyard manure—and consequently by other less readily soluble manurial matters, such as fish, dried blood, powdered horns and hoofs—is but transitory, and soon disappears if the soil is broken up and disturbed every year by the work of the plough. If the soil is left undisturbed it does not become impoverished, although yielding abundant crops.

These facts not merely agree with the results of other investigators,—I may especially mention Messrs. Lawes and Gilbert,—but are readily intelligible if we consider the effects of cultivation. The more the soil is broken up by the plough or the spade, the more pervious it becomes to air and water. In consequence nitrogenous bodies are quickly decomposed, and their nitrogen, under the oxidising action of the air, assumes the state of nitrates. These nitrates, being readily soluble, are dissolved by every shower of rain, and carried away as already explained.

This view of the case is simply alarming, and necessitates the question—How can a progressive deterioration of the soil, leading to ultimate sterility, be avoided or retarded?

The circumstance which M. Dehérain mentions, that the impoverishment of the soil is arrested if it is let alone, is, as a consolation, perfectly nugatory. The crops of which human food consists—at least in all the colder parts of the earth—are annual, and require a yearly ploughing. I need only mention all the kinds of corn, potatoes and other esculent roots, and the leguminous plants and herbs of the cabbage tribe. We cannot subsist upon the produce of orchards, both because of its precarious nature, and because during a great part of the year it necessarily fails us.

Pasturage and meadows, natural or artificial, do not meet the difficulty. A scanty population may indeed be supported on meat, milk, and other animal products; but as a country becomes more civilised and more densely inhabited, the relative number of cattle and sheep necessarily decreases, and the people are more and more driven to a vegetable

diet. Without at all adopting the extreme views of the so-called dietetic reformers, I must recognise that a progressive disuse of animal food is going on in most civilised countries. Nor can I forget the unfavourable influence of a pastoral life upon civilisation and morality. A nation of herdsmen, if it multiplies, is compelled to encroach upon its neighbours, and is always in a state of barbarism.

As for the intellectual state of such communities, I need merely point to the grazing districts of England. There are people who do little or nothing but drive cattle into a field and fetch them out again. Their fathers for five hundred years back have done the same, and any native who has ideas beyond bullocks leaves the neighbourhood and settles elsewhere.

The land cannot, therefore, be left undisturbed, unless we are prepared to return to a state of semi-barbarism. The population of Europe is already far greater than its area could support as herdsmen and shepherds. But it is possible, or rather probable, that there is a certain point up to which tillage may be carried with comparative safety, whilst if such point is exceeded the crops are not so much benefitted by the comminution of the soil as injured by the greater facility given to the waste of plant-food. This golden mean should be ascertained.

Again, it is generally asserted—though I could not at the moment lay my hands upon direct proofs to that effect—that soil, manure, season, and seed being the same, land tilled with the spade yields heavier crops than such as is under the plough. Has it been ascertained what is the comparative effect of these two methods of cultivation upon the soil? The spade breaks up the soil better than does the plough. Does it facilitate the waste of manurial matters to a greater degree, and lead more quickly to exhaustion?

Again, drainage is a necessity. Even with it we find, in a wet season like the past winter, the seed rotting in the ground. But is the facility for the escape of water from the soil, carrying with it of course such soluble matters as it meets with, not sometimes unduly increased? Here, probably, a golden mean should be sought for and observed.

The kind of manures applied has also to be taken into consideration. The two saline manures used by M. Dehérain in his experiments are exceedingly soluble, and when he employed farmyard manure, which is less soluble, the waste experienced was smaller, or in some cases gave place to a small improvement. It must here be asked, What is the key to the great difference traceable between the arable

lands of Western Asia, Northern Africa, and Europe on the one hand, and those of China and Japan on the other? The former group has, as we well know, received for centuries the manure produced in the farmyard, and has in most places become impoverished to a greater or less extent; but in China, where the bulk of the land has been under regular cultivation for probably two thousand years at least, where there is little or no pasture or meadow land, whether natural or artificial, and where the chief manure consists of human excreta, the soil under this treatment is said not to have become deteriorated or exhausted. Of course no analysis of Chinese soils, as they existed from 2000 to 3000 years ago, are to be procured; but there is no reason to suppose that they were at the outset richer than those of the rest of the world. We know that the soil was let alone, and we can only therefore infer that their manuring has kept up the fertility of the land.

This brings me to the question of sewage-irrigation. It has been admitted, as far as I am aware, by one of the arch-advocates of this method of disposing of fœcal matters, that two-thirds of the combined nitrogen present in the sewage may, instead of being retained by the soil, pass out in the effluent water. This statement, in the light of the experiments of M. Dehérain, becomes highly probable.

Nitrogenous matter dissolved or suspended in a large excess of water, and passed through a porous medium, such as the soil, can scarcely fail to undergo decomposition, the ultimate product being nitrates. Hence it will appear that sewage irrigation must for ever fail in utilising the whole, or even the greater part, of the nitrogen present in human excreta. In sewage precipitation, on the contrary, much of the "organic nitrogen" of the Franklandians, or the "albumenoid ammonia" of the Wanklynites, forms a combination with alumina, and is only gradually rendered soluble in the soil. In this manner it is much more likely to minister to the wants of a growing crop.

The double objection to the old method of dealing with sewage, *i.e.*, running it into the nearest river, is that it wastes manurial matter, and that it renders the water of such river what is now called a "culture solution"—that is, a liquid in which Bacteria, of sorts, if once introduced may increase and multiply. But the difficulty of dealing with this double evil now appears. If we turn the sewage of a town, not directly into a river, but pass it over an irrigation field, the bulk of the combined nitrogen still finds its way into the stream and is wasted. From the sanitary point of

view the case is not very much better. True, a very dilute solution of alkaline nitrates will not, so far as is known, have any directly injurious action upon the health of men or animals who may drink it. But should disease germs be introduced into the stream—a contingency which can never be absolutely excluded—they will find in it abundant pabulum. Even in the absence of sewage irrigation a stream flowing through manured and cultivated lands can never, if M. Dehérain's experiments be trustworthy, be absolutely free from nitrates. Phosphoric acid will probably be also present, if, at least, wet weather should quickly follow the application to the fields adjoining of a manure rich in soluble phosphates. This will be especially probable if the soil is poor in carbonates of lime or magnesia. From my own observations I am inclined to think that if sanitary chemists would search more generally and carefully for phosphoric acid in the water of streams, ditches, and drains, they would be not unfrequently successful.

I remark here that Dr. B. W. Richardson seems to regard the vast quantity of plant-food carried by rivers into the sea as a question not of capital moment. He contends that it is not lost, but is utilised in the production and maintenance of marine organisms. This view is in one sense perfectly justifiable. But whatever is withdrawn from immediate utilisation is, practically speaking, lost. Were all the plant-food thus poured into the sea retained upon the land, it might be made to circulate many times through the bodies of vegetables and animals in less time than it can be recovered from the sea in the form of fish for human food, or fish-manure. For the marine animals which we use for either of these purposes do not feed directly upon the nitrates, the ammonia, and the phosphates which we pour into the sea. These bodies serve firstly for the nutrition of marine plants, and it is only after a long series of transformations that they enter the cycle of human wants and applications.

Perhaps the results of M. Dehérain may help us to understand the function of humus. No one, after the many experiments and investigations which have been carried out will return to the old notion that it furnishes plants with any direct nutriment. But by supplying carbon to the oxygen of the air it may retard the oxidising action of the latter upon nitrogenous compounds. Its powers of absorption and retention also will probably prevent the nitrates when actually formed, and the other soluble constituents of plant-food, from being conveyed away as

rapidly as will be the case in soils poor in organic matter.

It is curious to contrast the conclusions of M. Dehérain with, *e.g.*, the views of Jethro Tull, who maintained that the fertility of a soil was capable of being improved and maintained indefinitely by constant turning over and pulverisation.

V. FLOWERS AND INSECTS.

By J. W. SLATER.

ONE of the most popular and interesting portions of the New Natural History is that which discusses the relations between flowers, on the one hand, and insects and certain birds on the other. But its very interest and importance, not less than the support which it lends to the Doctrine of Descent, secure for it in some quarters an obstinate opposition. This hostility, as might be expected, is met with chiefly in France, where official science and alethophobia still shut their eyes to the constantly accumulating evidence in favour of Evolution.

The case, as presented by Darwin and his followers, is this:—It has been experimentally proved that in plants the close relationship of the sexual cells is unfavourable to the reproduction of the species. If the pollen of a flower has been applied to the stigma of the same flower (self-fertilisation) the seeds will prove less productive and give rise to less vigorous plants than if they had been "cross-fertilised"—*i.e.*, if there had been applied to them the pollen either of a different flower of the same plant or of a flower of another plant. It is, further, beyond dispute that in many flowers there exist formal obstacles to self-fertilisation which might even be regarded as special contrivances for its prevention. Sometimes the male organs of a flower come to perfection not at the same time with its female organs, but either sooner or later, so that the stigma can only be acted upon by pollen from some other flower. In other cases there are mechanical arrangements which prevent the pollen of a

flower from being applied to its own stigma. Hence it is plain that if fertilisation is to be effected at all—which is an absolute necessity—pollen must be conveyed to it by some special agency. Of such agencies we know only two—the wind and certain living beings, especially insects. That insects do take an active part in the fecundation of certain flowers we have very complete proof. We find that flowers are abundantly visited by insects belonging to various orders, especially butterflies, moths, bees, some wasps, Diptera (especially those belonging to the family of Syrphidæ), and a few flower-haunting beetles. We observe in plants a variety of arrangements by means of which insects visiting the flowers are sure to carry off a quantity of the pollen adhering to their wings, which is then transferred to the stigmata of the next flowers visited. On the other hand, we notice varied and complicated arrangements for keeping off such insects as would, from the nature of their habits, not subserve the great work of fecundation. This fact was first observed and recorded by the late Thomas Belt, and has since been studied in detail by Prof. A. Kerner, whose "Flowers and their Unbidden Guests" gives full information on the subject. Some of the habits of insects seem to have a decided reference to the fecundation of plants. Not a few forms, in their search for honey and pollen, confine themselves to one species of plant, or at least to one type. Others, though not thus limited,—*e.g.*, the common honey bee,—do not visit all flowers promiscuously, but devote themselves on each journey to some species of flower. Lastly must come the most decisive piece of evidence, that in the absence of certain insects flowers are unable to mature their seeds. To enable the red clover to reproduce itself, in New Zealand, it has been found necessary to import humble-bees. So far, then, the most obstinate votary of the Old Natural History can find no pretext for dissent or doubt. But it has been found practicable and necessary, taking the above-mentioned facts as a basis, to go much further. It has been observed that whilst some plants—hence called anemophilous—are so constructed that they may readily be fertilised by the pollen of other plants as conveyed by the wind, in others this kind of fecundation is impossible or highly difficult, and the services of insects or of birds are necessary. These latter plants, known as entomophilous, if compared with the anemophilous group, present certain well-marked characteristics. They offer distinct and often brilliant masses of colour, or in place thereof they give off a striking odour. This is not the case with the anemophilous plants. In them

the calyx and corolla, which in the entomophilous plants are the seat of colour, are wanting. Hence in popular language they are said to have no flowers. To this day many people laugh if we speak of the flowers of an oak, an ash, or a fir.

We next notice—as it has been proved by Sir John Lubbock in numerous and elaborate experiments—that insects, and especially bees, possess a sense for colour, and not only distinguish one hue from another, but have their preferences. That they have a delicacy and a discrimination of scent far surpassing that of the bloodhound needs no demonstration. It appears, further, that powerful odours and brilliant colours are very rarely combined, but seem mutually to substitute each other. Hence the conclusion is drawn that both the colours and the odours of flowers serve to attract insects, and thus to ensure fecundation. The more bright and conspicuous a flower the more readily it is seen by bees and butterflies, and the more likely it is to be visited. Hence a number of the peculiarities of the vegetable world become intelligible which would otherwise be unmeaning. The cowslip, as Mr. Grant Allen has recently pointed out, carries its flowers on a stiff and relatively tall stem, because it grows on level ground. The primrose, with its slender drooping stem, prefers the slopes of banks and hillocks, and has a larger and brighter flower. Our ordinary heaths and wild thyme have exceedingly small flowers, and form a low carpet over the ground; but they grow where they are not overshadowed by trees or bushes, and their individual blossoms are so numerous and closely-set together that they cannot easily be overlooked. The foxglove haunts the woods, the coppices, and the sides and interstices of rocks; hence to be visible it requires a tall stem and fairly-sized richly-coloured blossoms. The poppy, like the cowslip and the primrose, is an inhabitant of the fields; but it flowers not in early spring, but when the grass and corn have grown high enough to hide any lowly plant: hence we see its intense scarlet cup supported by a moderately tall stem.

In our northern regions few large trees bear conspicuous flowers, and in accordance with this circumstance we see the bees, the butterflies, and the moths skimming and fluttering at a moderate height. In tropical forests all below is often poor alike in animal and vegetable life, whilst huge and brilliant flowers are basking in the sunshine high overhead, and there accordingly such magnificent forms as the Papilios and Ornithopteras keep them company.

So far, again, the opponents of Evolutionism can allege little in objection. They may dislike the inferences to which experiment and observation obviously lead, but the facts themselves are scarcely to be gainsaid.

But we come now to the last step. Putting all the above considerations together most naturalists infer that in earlier ages plants were self-fertilised as certain of the flower forms still are; that anemophilous plants mark in some cases the next steps in advance, or possibly in others a decline from the ultimate or entomophilous state; that the brilliant infloration of the higher plants has been gradually evolved in the course of the struggle for existence. The more colour a plant displayed the more certainly it would be visited by the bee and the butterfly; the more certain these visits the greater is the probability of cross-fertilisation, and consequently the chance of the production of viable seeds.

Here, however, as we might expect, a variety of voices are raised in opposition. Among those who seek to controvert the views above expounded on the part played by insects in the fecundation of flowers, a prominent position is taken by a French botanist, M. Ed. Heckel. This gentleman, who must not be confounded with Prof. Ernest Haeckel, of the University of Jena, contends that the colours of flowers have not been evolved with any relation to the perceptions of insects. He calls attention to the brightness and purity of colour displayed by the Alpine flora—an indisputable fact. He then goes on to maintain that in the elevated mountain regions bordering on glaciers and snow-fields, insects are either wanting or are at least too few to play the part assigned to them by Darwin, Sir J. Lubbock, Dr. Fritz Müller, Mr. Grant Allen, and a host of well-known observers, English, German, and American.

On the other hand, M. Ch. Musset, after four years of observation in the Alps of Dauphiné, confirms the views of Darwin and his coadjutors, and refutes M. Heckel's assertion as to the absence or extreme rarity of insects at great altitudes. He shows that all the different orders of insects are fairly represented up to about 7000 feet above the level of the sea,—the altitude of course varying with climate and exposure,—and that even at greater heights the Lepidoptera, Hymenoptera, and Diptera were more numerous than the other orders. But the groups mentioned are precisely the flower-frequenters, whilst the Neuroptera, Orthoptera, and Hemiptera contribute little or nothing to the fecundating process, so that their absence or scarcity is from this point

of view of no importance. The number of honey-loving insects was, in short, proportionate to that of flowers.

We must pay especial attention to the reply of M. Heckel. He does not seek to deal with the facts of M. Musset, nor does he adduce any counter-observations. He writes:—"I persist in maintaining that fecundating insects are not in any manner the cause of the luxuriance of the floral system in some Alpine species." If we were to pronounce this a typical specimen of Anti-Evolutionist reasoning we should not improbably be accused in certain quarters of "intolerance." We will therefore leave it to the judgment of our readers, and pass on to an argument which M. Heckel vouchsafes to bring forward. He submits that if the especial beauty of the Alpine flora is due to the action of insects they must be present not merely in moderate quantities, but actually in greater numbers than in the low grounds, which M. Musset does not assert! This strange plea convinces us that M. Heckel does not take the trouble to understand, or at least fairly to represent the workings of the struggle for existence. If butterflies and bees were entirely absent, of course they could have no action, and the colouration of the flowers would neither be assumed nor modified to suit their perception. But are we therefore warranted in concluding that the more numerous these insects are the greater will be the effect produced? Decidedly not: if the honey-loving insects become very numerous their influence will substantially cease. In their eager quest for honey every flower, whether conspicuous or otherwise, will be visited. Those of bright and pure colour will cease to have any marked advantage over such as are dull and ordinary. There will hence be no reason why a flower more brilliant than others of its species should have any advantage over them in securing cross-fertilisation, and consequently in leaving more numerous descendants. But let us suppose, as is actually the case, certain plants growing about the very margins of perpetual snow. Bees and butterflies will not be too eager to make a very minute search in regions so closely bordering on the absence of life. But if they espy from afar, *e.g.*, an Alpine pink, they will hasten to it at once, and secure its cross-fertilisation. Thus the more brilliant a flower the more certain it is to effect the object of its existence. The most beautiful will be selected and the dullest overlooked far more certainly than in some region where the swarm of insect visitors was greater.

We may here mention that, according to Sir Robert Schomburgk, there exists on the mountains of British

Guayana an exceedingly rich flora, with but a very scanty fauna as far as insects are concerned. This assertion needs further examination. Waterton had previously visited the same regions, but he has unfortunately left nothing on record which might throw any direct light upon the question, though he states in the "Wanderings" that "almost every flower of tropical climates contains insects of one kind or other," and generally speaking the mountainous parts of the Neotropical region are by no means poor in insects adapted for visiting flowers.

It may be asked to what cause does M. Heckel himself ascribe the brilliance and purity of the Alpine flora? He seeks their origin in "the solar radiations, which are more intense than in plains."

Before at all accepting this explanation we must pause and ask whether the brilliant colouration of the organisms in any country bears a fixed relation to the clearness of its skies and the intensity of its illumination? There is—to put the case in the most cautious and moderate manner—no evidence to this effect. The brilliant skies of Persia, Arabia, and the Sahara, free as they are from fog and cloud, have not fostered a brilliant flora and fauna. On the contrary, in those regions everything seems to tend towards what may well be called "desert-colour." On the other hand, the Cape of Good Hope has—or rather had, for the goats have destroyed it—a far more brilliant flora.

There is another fact to be considered and accounted for: what of the Alpine fauna? If the intensity of the solar radiations produces brilliant colouration in plants, should it not have a similar effect upon insects? Yet this is precisely what is not recognised. M. Heller remarks that, with the exception of the Chrysomelidæ, most Alpine insects are black or deep brown, and the higher we ascend the more sombre grow their colours. In other animals a similar tendency to melanism prevails. The fish in Alpine lakes have chiefly dark colours. Similarly among reptiles we find the jet-black *Salamandra atra* taking the place of the orange-blotched *S. maculata* of the plains. The common viper takes in high mountains an almost black colouration, and was formerly looked upon as a distinct "good species," under the name *Berus prester*.

But whilst the dark and dull character of the Alpine fauna militates decidedly against the above-mentioned hypothesis of M. Heckel, it is equally little in favour of the well-known views of Mr. Grant Allen. This able observer suggests that brilliance and purity of colour in the animal

world is to be found mainly among such groups as inhabit, dwell among, or feed upon flowers and fruits. He considers that every creature naturally comes to admire the objects from which it derives its nutriment. The tastes thus formed would then, through the medium of sexual selection, gradually act upon the species until those splendid colours were produced which we now so much admire in birds and insects. Exception has already been taken to this hypothesis from several points of view. But it seems that the brilliant flora of the Alps, taken in connection with its sombre insect fauna, is the most serious objection yet brought forward. The Alpine Lepidoptera and Hymenoptera, visiting and deriving their supply of honey and pollen from a brighter flora than that of the plains, should, if Mr. Grant Allen's theory be true, surpass their lowland representatives in gayness of colouration. That the contrary rule should prevail seems fatal to the hypothesis in question.

VI. EPPING FOREST: A CONGRATULATION AND A WARNING.

IT is rarely indeed that the proceedings of Parliament claim our attention. We must, however, take leave to express the satisfaction which will be felt by all naturalists at the recent defeat of the proposed branch of the Great Eastern Railway from Chingford to High Beech. Lord Claud Hamilton's sneer at the "butterfly hunters" has been answered by a majority of 120 votes. For the rejection of this piece of wanton intrusion and spoliation we are in no small degree indebted to the watchfulness and devotion of Mr. R. Meldola, F.R.A.S., who has communicated with the Natural History Societies of London and the suburbs, and brought their united influence to a focus. His most able address on this subject, delivered before the "Essex Field Club" on February 24th and reprinted in the "Essex Times," has made a deep impression.

It would be, indeed, difficult to find a project with less

questionable claims to public utility. We are told that no part of the forest is at present beyond the distance of one and a half mile from a railway station, whilst from Loughton a good road—crowded at holiday time with public conveyances—leads to the very High Beech which certain philanthropists think not sufficiently accessible.

Tavern accommodation, too, is ample. We have heard it whispered that there are certain plots of freehold land near High Beech, which, should the railway lately proposed be sanctioned, would greatly rise in value, for the very purpose of erecting more houses for the sale of intoxicants. It is said that this prospect is not unconnected with the piece of Vandalism which the House of Commons has for this season disposed of. Now we think it may safely be asserted that the more taverns are allowed to spring up in and near the Forest, the more disorder will take place, and the more the "rough" element will be attracted to the locality to the annoyance and disgust of all decent people, whether "butterfly hunters" or not. We think that from this point of view the friends of Temperance might wisely co-operate with the lovers of Nature in seeking to prevent any further desecration of the Forest. For those whose main holiday amusement consists in being drunk "with drunken knaves" there is already, both in London and its outskirts, most ample provision.

But there is a further danger: even supposing railway-directors and tram-companies are for ever debarred from encroaching upon the Forest, we may possibly find that by substituting the reign of the so-called Conservators for that of lords of the manors we have merely exchanged King Log for King Stork. The encroachers gradually stole the land, but they did not spoil what was left. Now, as one of our contributors endeavoured to show in our number for June, 1882 (page 341), and as Mr. Meldola has explained more clearly in his paper above mentioned, the action of the Conservators has been directed not to the preservation of the Forest in its original state, but to its "artificialisation,"—*i.e.*, its conversion into a "peoples' park." Now parks, "peoples'" or otherwise, exist already about London in considerable numbers, and, as compared with streets and houses, they are a relief to the eye. But as compared with a piece of natural forest they are to the last degree tame, formal, and monotonous. The Conservators, instead of ruining the Forest and banishing its

native flora and fauna by deep draining, removal of thickets, and cutting formal roads, might find much better scope for their energies and their funds in replanting those parts which had fallen into the hands of encroachers, and are now mere barren wastes. By so doing, and by simply letting the wooded parts alone, they will afford the greatest pleasure to the greatest number. The damage they have already committed is far from unimportant, and it is time that their injudicious hands were arrested.

ANALYSES OF BOOKS.

*Der Darwinismus und seine Consequenzen in wissenschaftlicher und socialer Beziehung.** By Dr. EUGEN DREHER. Halle: C. E. M. Pfeffer.

WE have here a thoughtful and elaborate investigation of the scientific and social consequences of Darwinism, or, as we should say, Evolutionism. The author, an adherent and admirer of Darwin, writes not as a specialist, but as a philosopher. Whilst fully recognising the importance of the "Doctrine of Descent," in Zoology, Botany, Palæontology, Geology, &c., he takes a wider view. He asks what light the researches of our Great Master have thrown upon the problem of life, and upon the Monistic and Dualistic interpretations of the universe? He shows the fertility of Evolutionism as regards the development of the so-called moral sciences, of ethics, æsthetics, and the yet rudimentary discipline to which Comte gave the name of Sociology. In this direction comparatively little has been done. With the exception of Mr. Herbert Spencer, of Mr. S. Tolver Preston, and Mr. F. Ram, the bulk of the writers in this country who have touched at all upon the ethical and social bearings of Evolutionism have contented themselves with representing it as tending to overturn the distinction between right and wrong, and generally to dissolve the very bonds of human society. Even in Germany it is painful to find that similar misconceptions exist. No less an authority than Prof. Virchow has sought to connect the unpleasant phenomenon known in Germany as "Social Democracy" with the rise and progress of the New Natural History.

Dr. Dreher, in his Introduction and in his first chapter, gives a clear, but necessarily concise, summary of the life-task of Darwin, of his forerunners,—among whom he singularly omits the great Oken,—and of his opponents. Among the latter he does not forget the "Brot gelehrten,"—trade-scientists,—the *savants* of centralising Academies and Departments, who from motives readily understood rarely fail to oppose any discovery of capital moment.

The author notes the importance of Haeckel's biogenetic law, according to which the individual in its embryotic career passes through what may be called a foreshortened series of the stages through which the species has travelled in its evolution.

* Darwinism and its Consequences in their Scientific and Social Relation.

He refers, though briefly, to the bearings of the Darwinian reform upon practical medicine and hygiene, in which regions it solves not a few difficult problems, and then passes on to his more immediate subject.

What of the origin of life, abiogenesis, or, as it was formerly called, equivocal generation? Here he admits that upon this question Darwin has thrown no conclusive light. He does not for a moment contend that—either in experimental observations, or in Nature as far as man has been able to trace—life has ever originated from inorganic matter without the presence of seeds, germs, or ova derived from antecedent life. But he repels the contention that if a Higher Power, a Deity, has once interfered with the ordinary sequence of cause and effect, such intervention may have been repeated, and all the various animal and plant types may have been specially created. To this plea he makes answer that though a Divinity might have so acted, yet on careful examination of the facts we find abundant evidence that such has not been the case. "As Evolutionism discloses a relation of organic forms which agrees with our craving for causation we must decline, on the principle of parsimony, to explain by dint of supernatural, and to us incomprehensible, forces, results which can be satisfactorily accounted for by the every-day principles of heredity and adaptation." Darwin does not attempt to account for origins, but given organic life he endeavours to show how from it the animal and vegetable worlds, as we now see them, have been developed.

The suggestion, taken up by Prof. Helmholtz, and we believe by Sir W. Thomson, that the first germs of life have been conveyed to our planet in meteorites, he sets aside by a very obvious consideration, which has more than once been put forward in our columns. "This assumption," he writes, "serves nowise to explain the origin of life, since the problem is thereby merely removed. Whether life first originated upon our earth, or in the realms of space, or in meteorites, is for our purpose indifferent, since we ask not *where*, but *how* it first began." This hypothesis becomes intelligible only on the assumption that life has existed in the universe from all eternity, and is conveyed by a succession of accommodating meteorites, from exhausted worlds to such as are just ready to become the abodes of organic existence.

The author then turns to the considerations by which Prof. E. Haeckel seeks to connect the inorganic with the organic world. Here it will be necessary for us to indulge in a little delay. There are two, or more strictly speaking three, fundamental ways of regarding the world. Dualism—which the author adopts not as satisfactory, but as the least unsatisfactory—presents the two heterogeneous principles spirit and matter. It distinguishes them by pronouncing all spiritual processes as essentially non-spacial, whilst all material processes, as phenomena of motion,

are not conceivable in the absence of space. Monism, on the other hand, teaches the unity of all that is. But this term is used in two very different acceptations. We have, on the one hand, Materialistic Monism, which recognises as the sole principle of all that takes place Matter, the something accessible to our senses. Spiritual operations are to the adherents of this school, in their essence, whether we may ever succeed or not in explaining them derived from material action. The other, or Pantheistic, school of Monism assumes as the unity of all being a something, the "substance" of Spinoza, which expresses itself in two forms, spirit and matter, the "attributes" of Spinoza. Individual beings are merely "modes" of this "substance."

It is the more important to know that this is the point of view which Haeckel adopts, as he is generally held up as a "Materialist," such adjectives as "crass" or "rank" being often thrown in. In a letter to the author he pointed out, some years ago, that the latter had raised against his interpretation of the universe "objections which might justly be advanced against one-sided Materialism." In fact Haeckel regards atoms as the smallest individualities, as each possessing a soul, and consequently, in however light a degree, as endowed with consciousness. He thus escapes the difficulty which the Materialists encounter, in deriving life and soul from a non-sentient, unconscious matter. He views crystals as the analogues of organisms or as the pristine organisms of the animated world. As the original organisms, in the common acceptation of the term, he regards not cells, but *Moneræ*. These he pronounces to be structureless, animated plasma.

The Materialist regards life as the simple result of matter under certain conditions. To him the spontaneous production of the higher animals only would seem improbable, as here the number of conditions which must coincide borders upon the impossible. This difficulty Darwin has certainly removed out of the way of Materialists by bringing the higher and the lower organisms into connection.

The author considers, however, that neither Monism nor Dualism is able to grasp the phenomena of life in a manner which shall satisfy the inbred and imperative demands of thought. Dualism is unable to explain how the non-spacial, the soul, acts upon the spacial or body, and conversely. It is also obliged to assume that the strict sequence of cause and effect, after having gone on for æons prior to the avatar of life, is suddenly interrupted by the introduction of a new factor ascribable only to a supernatural world. "Thus Dualism leads to the assumption of a God, and cuts off thereby the thread of further investigation, whilst we cannot help demanding for everything a natural cause. A First Cause, a *causa sui*,—whether we call it God, Nature, or Necessity,—is for us incomprehensible, since our whole thought is of phenomenal nature. The assumption of a supernatural

principle is by no means banished from the research if we are led to it by consequent thought, based upon experience."

The monistic interpretation of the universe, whether pantheistic or materialistic, breaks down from its incapacity to explain from a unitary principle the difference between matter and spirit. The Pantheist is unable to explain the duality of matter and spirit, in which the One Substance appears to itself; the Materialist is incapable of showing how phenomena of motion can become spiritual processes. Hence it must be admitted that the above-mentioned interpretations of the world—the only ones which man can conceive—are not even able to grasp satisfactorily the phenomenal side of Nature, much less to admit of a conclusion as to the essence of the order of the world. The author, reminding his readers of the necessarily phenomenal character of our knowledge, views in Monism and Dualism schemes of the mind, each having a "one-sided justification" which we may recognise without raising against the former the charge of Atheism and immorality, or against the latter the accusation of credulity and superstition.

Whilst, however, thus seeking to recognise in each of these interpretations of the universe its valuable element, he declares himself an adherent of Dualism, founding his choice upon the doctrine of cognition. In this recognition of spirit and matter as the two substantial entities which make up the world, he follows the footsteps of Darwin, as it appears from the concluding passage of the "Origin of Species." He even considers—like not a few philosophic naturalists, both of his own country and of America—that Dualism will be of more service to the Darwinian than Monism. Combating the views of Haeckel, he emphasises the distinctions between the organism and organic individuals—crystals. He argues that no crystal is capable of reproduction. But we may here ask whether he has sufficiently borne in mind that, in the lower forms of life, reproduction, the increase of the species, is not so sharply differentiated from nutrition, the increase of the individual, as in the higher groups. Nor can we agree with him in maintaining that "every individual, even before its birth, carries in it the germs of death." We have some time ago shown that death is not the necessary lot of all living.

Whilst admitting the possibility that modern chemistry may succeed in the synthesis of all organic compounds, he maintains that, even were it possible to form artificially an entire animal, not merely chemically, but structurally, identical with those we meet with in the world, it would be a mere corpse, without an immaterial something. Nevertheless he holds that every vital process, regarded in itself, is the result of material processes, or, in other words, a phenomenon of motion.

In the remaining chapter, which the want of space prevents us from examining in detail, the author discusses, from an

Evolutionist point of view, the conscious and the unconscious element of the soul, memory, animal instinct, the struggle for existence between nations, necessity as the power impelling to improvement, and the pessimistic and optimistic side of Darwinism.

We have thus briefly expounded, without either seeking to advocate or to controvert, the principal portion of Dr. Dreher's views. Those of our readers who are anxious to get to the bottom of the Evolutionist philosophy will do well to give this book a most careful study.

The Gardens of the Sun; or a Naturalist's Journal on the Mountains and in the Forests and Swamps of Borneo and the Sulu Archipelago. By F. W. BURBIDGE, Trinity College Botanical Gardens, Dublin, and formerly of the Royal Gardens, Kew. London: John Murray.

SINCE the days of Arnold and Horsfield, and still more since the memorable expedition of Mr. A. R. Wallace, the Malay Archipelago has been for naturalists a veritable promised land. To those who, like ourselves, have not had the felicity of a personal sojourn in these islands, every faithful record of observations there is most warmly welcome.

The author of the book before us is evidently an able and enthusiastic botanist and plant-hunter. With animal life he is less conversant. We find here relatively little information on the distribution and the habits of birds and insects, and in comparative psychology Mr. Burbidge does not show to advantage. Of this the following passage is ample proof:—"After all the orang-utan is a poor creature, with but an outer resemblance to the human species. In intelligence he is not only far below the lowest savage, but even inferior to the horse or the dog. No amount of teaching will make the orang-utan or any other ape practically useful to man. Do all we can for them in a state of confinement they are simply big helpless monkeys to the last."

Anyone who has closely and candidly observed the mias or the chimpanzee in confinement cannot fail to perceive that, lacking all the advantages of hereditary training, and suffering from ill-health, as they invariably do in confinement, they are still vastly superior in intelligence to the horse, the dog, or the elephant. Whether or no they can be made "practically useful to man" is a totally irrelevant and non-scientific consideration.

Like Mr. Wallace, the author defends the natives of the Eastern Islands from random accusations. He maintains that

there, whilst "Nature is ever beautiful, man, although often strikingly primitive, is hospitable to the stranger, and not often vile." Vileness, indeed, we may best find at home. The "rough" of our modern cities is, in most respects, a more degraded character than the barbarian.

We find it noticed that "one particular species of kingfisher always makes its nest in company with that of a colony of wild bees." The author suggests that its young may be fed on the larvæ, or perchance the company of the bees may be courted for the sake of their protection in case of the nest being attacked."

A very curious observation is made concerning *Nepenthes bicalcarata*, a new pitcher-plant discovered and introduced by the author. Its pitchers, which always contain insects of various kinds, are armed at their entrance with two sharp and strong spines. Mr. Burbidge is convinced that the spines serve to prevent birds and insect-hunting animals—such as the tarsier—from removing these insects, which doubtless serve as nourishment to the plant. The author has also observed the *Myrmecodia* described by Beccari, who asserts that unless the young seedlings are bitten by a species of ants which always inhabit the stems, they die. Mr. Burbidge is unable to confirm the view taken by the Italian naturalist.

Of Singapore, where the author made some stay on his outward journey, he gives a very elaborate description. He notes the rare and beautiful orchids which grow in cocoa-nut shells hung from the verandahs of the houses, the museum of the Raffles Institution, the Botanical Gardens, and the Chinese immigrants. Concerning the latter he remarks that "wherever they are admitted a strong hand is needed to keep them in order." On a visit to the mainland he notices the preparation of gambier, which he describes as "a very exhausting crop, literally ruining the land on which it is grown." In the jungles and on the rocks he obtained many interesting botanical specimens, and here he first made the acquaintance of the land-leeches. The argus and the fire-backed pheasant are noticed as common. In the Malay peninsula there exists a tribe who are commonly known as Orang-utan—a confusing practice: hence it is preferable to speak of the great ape of Borneo and Sumatra as the "mias." On his voyage to Borneo he saw a sea-snake, about 8 feet in length, basking on the surface of the water. This species is said to be very venomous, and occasionally to hide itself in boats or in huts near the shore.

In Borneo he finds a wonderful beauty and luxuriance of vegetation, but, except where a partial clearing had been made or a tree overthrown by a tempest, all the rarities, animal as well as vegetal, were high aloft. Every evening he was able to send his men home loaded with roots and specimens. He remarks that, for all the absence of law and government, the proportionate

number of murders and robberies does not exceed the amount taking place in the centres of civilisation. Islam, from its inculcation of cleanliness and temperance, he considers a great blessing to many Eastern races. The gutta-percha trees, of which there are at least five species, are surely being extirpated in Borneo, as well as in the other islands. The caoutchouc from Borneo is also the mixed sap of three species of *Willughbeia*.

The ascent of Kina Balu, 9000 feet in height, proved exceedingly productive in botanical rarities, such as "Imperial Kew had longed for in vain." Luminous fungi were noticed glowing by night on the rotten sticks in the woods, but concerning the insect population of this region nothing is recorded.

In the island of Labuan the primeval forest has been devastated by fires, and much of its characteristic vegetation has disappeared. We doubt the supposition that it has been rendered healthier, as in most tropical regions epidemics such as cholera and yellow fever extend just in proportion as the country is cleared. Mr. Burbidge notes the sweet song of *Copsychus amœnus*, the only bird peculiar to Labuan. Several venomous snakes are mentioned, but fatal accidents from this cause are very rare. One species, not named, swallows smaller snakes, but can scarcely be on that account pronounced a cannibal unless it preys on its own species. The sun-birds he notes as representing the humming-birds of the Neotropical region. Like the latter they hover over our blossoms, but they perch more frequently, and often feed clinging by their feet, sometimes head downwards. The humming-birds, on the contrary, take their food whilst on the wing, as do the swifts, and among insects the Sphingidæ. The spiders are described as of "alarming size," but gaily coloured. There are oil-springs in Labuan, but the product is carelessly let flow to waste. The author describes some mason-wasps and large black carpenter-bees.

It is interesting to find that at heights of 7000 feet and upwards, on the Bornean mountains, Australian types of vegetation appear. A curious ethnological fact is that Malay and Bornean women, if married to Europeans, rarely bear children, and if they do the offspring of such unions are ordinarily incapable of reproduction. On the other hand, half-breeds between Chinese and Malays or Borneans are numerous and healthy.

Mr. Burbidge asks, "How comes it that none of our good landscape-painters ever visit the tropics, where the beauty of form and colour in the landscapes is more glorious than anywhere else?"—a question which we are disposed to echo.

At Sandakan, on his way to Sulu, the author met with Mr. W. B. Pryer, the well-known entomologist, who had made a splendid collection of Lepidoptera and Coleoptera, including several forms supposed to be new to Science. In the Sulu Islands he remarks the number, beauty, and variety of butterflies, but gives no clue as to the species, or even genera or families. He mentions,

however, that an Ornithoptera, fully 6 inches across the wings, settled on his foot as he stood motionlessly watching it. It was of a velvet-black, with a band of pea-green across the wings.

In one of the last chapters of his book Mr. Burbidge gives an eloquent, but as far as we can learn by no means exaggerated, description of the native fruits of the Malay Islands, such as the mangosteen, durian, taripe, langsat, rambutan, and jintawan. These are neither capable of production in European hothouses, nor do they succeed in other tropical countries. Thus the durian does not flourish in India, and has utterly failed in the West Indies. In like manner the mangosteen has failed both in India and the West Indies, and succeeds but imperfectly even in Ceylon. The mango is less limited in its distribution. It has been successfully acclimatised in India, Jamaica, and even in the Azores. "The shaddocks brought to Covent Garden from the West Indian Islands and the Azores are flavourless as a turnip when compared with those of Bangkok or Labuan."

The author's concluding hints on tropical travel are not without interest. He recommends three medicines, but as two of them are so-called "proprietary" articles we must decline to quote their names. He does not imitate Waterton's strange custom of walking barefoot, but enjoins good strong boots. Not being a collector of insects, land-shells, serpents, &c., he has no experience to communicate either as to the capture of specimens or on their safety in transit.

The appendices give a catalogue of ferns, fifty of which were new. Twenty species of birds were brought from the Sulu islands, among which rank a new jungle-cock (*Gallus stramineicollis*) and a new parroquet (*Tanygnanthus Burbidgei*). *Buchanga stigmatops*, a new species, was found on the Kina Balu mountain.

The flora of Borneo at high altitudes is said to be intermixed with Indian (*Rhododendron*) and Australian types (*Dacridium*, *Phyllocladus*, &c.). On Kina Balu, at the height of 6000 feet, was found a gigantic moss (*Dawsonia superba*), which has hitherto not been met with nearer than New Zealand. The number of plants discovered, and in many cases introduced alive, is remarkable, and warrants the conclusion that the expedition of Mr. Burbidge has been most remunerative. It is to be regretted that he was not accompanied by a zoological specialist, since, as he remarks, a very great part of Borneo is yet unexplored. To all students of Nature his book will be delightful reading.

The Electrical Researches of the Honourable Henry Cavendish, F.R.S., written between 1771 and 1781. Edited from the Original Manuscripts in possession of the Duke of Devonshire, K.G. By J. CLERK-MAXWELL, F.R.S. Cambridge: University Press.

As a matter of course these researches have now, a century after their production, an interest which is mainly historical. Henry Cavendish has always been to us a remarkable phenomenon. There have been men his equals and doubtless his superiors in intellect, but there probably never was a man in whom every other phase of human nature remained so exclusively in the back-ground, if indeed it could be said to exist at all. The hopes, the fears, the desires, the passions, and the temptations of ordinary men were in him conspicuous chiefly by their absence. He had no place on the ethical plane, which slopes from virtue down to vice. He was free even from the ambition, the vanity, the love of notoriety, and from the feelings of rivalry and envy which not a few *savans* manifest to a deplorable degree. An instinctive love for truth led him constantly to observe and to experiment with the utmost care and exactitude. But he was in no haste to publish his results. We read in the work before us: Cavendish cared more for investigation than for publication. He would undertake the most laborious researches to clear up a difficulty which no one but himself could appreciate, or was even aware of, and we cannot doubt that the result of his inquiries, when successful, gave him a certain degree of satisfaction. But it did not excite in him that desire to communicate the discovery to others which, in the case of ordinary men of science, generally ensures the publication of their results. How completely these researches of Cavendish remained unknown to other men of science is shown by the external history of electricity.

Thus Cavendish fell into an error opposite to that of our official scientists and Brodgelehrten, who in their haste to "take date," are said sometimes to mistake the researches of others for their own. But Cavendish was no "Brodgelehrter."

We have here a case of heredity. Lord Charles Cavendish, the father of Henry, was also an experimentalist of merit, and, like his son, cared little for publication. Dr. Franklin said of him: "It were to be wished that this noble philosopher would communicate more of his experiments to the world, as he makes many, and with great accuracy."

It is here noticed that, whilst Henry Cavendish had a wonderful power of making correct observations and getting accurate results with clumsy instruments, he had a less inventive genius in devising improved apparatus than some of his contemporaries. The extent to which he has anticipated the results of more recent physicists is remarkable. He not only anticipated

Faraday's discovery of the specific inductive capacity of different substances, but even determined its numerical value in several cases. As early as January, 1781, he anticipated the law of electric resistance, afterwards independently discovered by Ohm, and published by him in 1827. He experimented on the relative electric resistance of a series of acids and salts, and it is remarkable that the quantity of each substance used is "very nearly the equivalent weight of that substance in the system adopted at present, in which the atomic weight of hydrogen is taken as unity." The editor of the work before us thinks that, as these experiments were made in 1777, Cavendish must have obtained these numbers from determinations of his own, of the very existence of which we have no other indication.

In his memoir on the Torpedo, laid before the Royal Society in 1776, he treats of the different conductive powers, or rather of the resistances, of certain solids and liquids. He mentions that iron wire conducts about 400 million times better than rain or distilled water, and that sea-water, or a solution of 1 part of salt in 30 of water, conducts 100 times, and a saturated solution of sea-salt about 720 times better than rain-water. The editor remarks that this is equivalent to saying that iron wire conducts 555,555 times better than a saturated solution of sea-salt. At a temperature of about 11° C. (=52° F.) the ratio of the resistance, according to Matthiesen and Kohlrausch, would agree with that given by Cavendish.

In the memoir aforesaid an account of the methods by which these numbers were obtained was promised. But it has lain buried till the publication of these papers. Cavendish was his own galvanometer, and compared the intensity of currents by passing them through his own body. How by so rude a method he obtained so close an approximation to the truth is a marvel.

"The leading idea which distinguishes the electrical researches of Cavendish from those of his predecessors is the introduction of the phrase 'degree of electrification' with a clear scientific definition, which shows that it is precisely equivalent to what we now call potential."

Lord Stanhope's "Principles of Electricity," a work very popular at one time, was evidently written in entire ignorance of what Cavendish had done. The latter devotes two pages to the refutation of the theory of electric atmospheres, which is the basis of Stanhope's reasoning.

Much has been said concerning the extent to which the researches of Coulomb have been anticipated by Cavendish. It is here pointed out that the method by which Coulomb made direct measurements of the electric force at different distances, and that by which he compared the density of the surface-charge on different parts of conductors, were entirely his own, and were not anticipated by Cavendish. But the very idea of the capacity

of a conductor as a subject of investigation is entirely due to Cavendish.

It cannot be doubted that had Cavendish been less reticent, and had he submitted his results to the world, electrical science would have made greater advances than it has at present.

The Weather of 1882 *as observed in the Neighbourhood of London, and Compared in all Respects with that of an Average Year.* By EDWARD MAWLEY, F.M.S., F.R.H.S., Hon. Sec. National Rose Society. London: Edward Stanford, and Williams and Strahan.

A CAREFUL examination of this little summary will convince the reader what careful and prolonged observation is required in order to give a correct notion of the climate of any country. The total yearly rainfall, the mean annual temperature, throw practically no light upon the influence of a climate on human health, and, what is perhaps even more important, on the growth of the plants necessary for our sustenance. We want to know whether the yearly rainfall is due to a few violent showers, or to sempiternal drizzle; whether the bulk of the downfall is in summer or in winter, in the night or in the day. As to the temperature we have, in like manner, to enquire whether the heat comes when it is wanted to mature the crops, or at some time when it can be of no service.

When we turn over Mr. Mawley's work, all wonder as to the frequency of bad seasons in England disappears, and we are almost led to marvel, on the contrary, how we ever come to have a good harvest at all. Of the three evil factors,—cold, wet, and wind,—it is seldom that all are simultaneously absent for an entire season. Our yearly mean temperature, 49½°, is not only very low, but it is too often made up not so much by good growing heat in summer as by the absence of frosts in winter. Our rainfall, though not large *per se*, is very high as compared with the insignificant evaporation under a cloudy sky, and it is administered in small but continuous doses, good, perhaps, for grass, but bad for almost every other crop. Perhaps the worst of the three factors is wind, which we have always in excess, though not always to such an extent as in the year 1882. The injurious effects of wind upon vegetation, though well known to gardeners, are quite overlooked by the general public. One main part of the advantages of cultivation under glass is that the crops are maintained in a calm atmosphere. It is certain that the extent to which the country has been denuded of trees has been in this

respect a serious blunder. We endorse the recently-expressed opinion of an American contemporary that if we leave one-fourth of a country covered with wood, the remaining three-fourths will produce more food for man and beast than would the whole, if entirely stripped. Could we regulate the climate at will we should fix for the velocity of the wind from the appearance of the blossoms to the ingathering of the harvest a maximum of 5 m les per hour. Last year the hourly mean for the three summer months was above 12 miles. In compensation we had a calm in January, when it could merely serve for the production of fog. The most remarkable meteorological event of the year was the destructive gale of April 29th, which in a few short hours undid the work of what had up to that date been a most propitious spring. The mischief, too, was effected, not by our old enemy, the north-east, but by a south-westerly current. Nothing can prove more clearly the necessity of having the country intersected by belts of timber, preferably conifers.

The mean amount of cloud during the critical time, from the beginning of June to the middle of October, was above the average. Thus the sun was shut off to an unusual extent, and the ripening and gathering of corn, &c., were greatly interfered with. There is one point which we think meteorologists generally overlook, *i.e.*, the comparative cloudiness of the sky during the day and during the night. It can scarcely be denied by any one at all versed in physics that were the heavens during the spring and summer always overcast at night and always clear in the day, spring frosts would become exceedingly rare, and our summer temperature would be markedly improved. But, as far as can be decided by mere observation, in all our bad seasons the very reverse holds good. The sky clears up at nightfall, and the warmth of the earth is allowed to radiate freely into space. Soon after sun-rise the clouds collect again, and the soil and the atmosphere are hence deprived of the necessary supply of heat.

Mr. Mawley notices the general failure of hops, apples, pears, and plums, and the absence of flavour in bush-fruits and strawberries.

Bee-keeping proved unsuccessful, wasps were rare, the caterpillar of the gooseberry moth (*Abraxas grossulariata*) did very little damage, but Aphides and indeed all kinds of blight were unusually destructive.

Mr. Mawley's records of the weather taken in connection with their effects upon animal and vegetable life will be very valuable, not merely to scientific men, but to the practical farmer and gardener. We hope the author will receive due encouragement to persevere with his laborious task.

Longman's Magazine, No. V., March, 1883.

In the current number of this magazine we come upon a few matters which we may legitimately notice. "Bits of Oak Bark," a rural trilogy of Richard Jefferies, betrays the close and accurate observer of the fields and the woods. In its second part, "The Legend of a Gateway," we read how a lady heard the gallop of her lover's horse in the lane, and heard his peculiar whistle at the Gateway at the very moment when he was crushed to pieces at a level crossing some twelve miles away. Not a word reveals whether the quaintly-told story is an outgrowth of the writer's imagination, or a legend which it might be impossible to trace to its source, or an ow're true tale which could be verified with all the details of time, and place, and names. We can but repeat in comment that the introduction of such incidents in popular literature points to a decided change in the public taste. To what does this change point?

The same writer makes a passing remark worthy the notice of those who still maintain that beauty exists for man's entertainment. "I thought how the apple tree in blossom before us cared little enough who saw its glory. The branches were in bloom everywhere, at the top as well as at the sides; at the top where no one could see them but the swallows. They did not grow for human admiration: that was not their purpose." This reflection is the more significant as coming from one who is assuredly not collecting evidence against the old teleological school, which viewed everything in Nature as existing for man's use or delectation.

"Health in a Health Resort," by Dr. B. W. Richardson, though containing many valuable suggestions, leaves, after all, a deep feeling of sadness in the mind. For to what end is it to lengthen life unless the quality of life could be altered? After all, it is better to die of swift zymotic diseases than of softening of the brain, heart affections, albuminuria, general debility,—the outcome of worry and competition!

The Mason College Magazine. Edited by Students of Mason College, Birmingham. Vol. I., No. 1. January, 1883. Birmingham: Cornish Bros.

We have great pleasure in welcoming this young contemporary. It appears that about two years ago the students of the Mason Science College felt themselves led to form an association for

social and intellectual intercourse. This society, now known as the "Mason College Union," seems to have led to the little magazine before us, in which its future proceedings will be duly reported. From the number before us we learn that "Professor Haycraft is completing a test for uric acid by which a quantitative analysis can be made in about fifteen minutes."

We were not aware that the plan of the Mason College included the study of classical literature. Such, however, it appears is the fact. We further learn that Prof. Bodington, who has filled the classical chair, has resigned it for the post of Principal and Professor of Classics at the Yorkshire College. This is an interesting fact. The Yorkshire College was originally founded for the study of Science alone. Then literature was added, and now already the office of Principal is committed to a Professor in that department! We fear that the emancipation of Science is not so near as the "poor humanist" seems to apprehend.

In the editorial introduction we note the just remark that—"The science of the philosopher is a very different thing from the science of the vulgar, which is nothing more or less than some form or other of art." Against this confusion, which is more rife in England than elsewhere, and in which public speakers and eminent writers freely indulge, we have protested all our life, but in vain.

One point in the proceedings of the College Union which we notice with scant satisfaction is the tendency to political debates. Thus we find among the proceedings of the year past a discussion on the abolition of an hereditary House of Lords; and in the course of last month (February, 1883) the subject for debate was that the prohibition of religious subjects from debate ought to be abolished. It is to be feared that political discussion will, in the Mason College as elsewhere, prove not favourable to the growth of profound and original thought.

Among the causes of that racial degeneracy against which Mr. Herbert Spencer has so earnestly cautioned the American people, Dr. G. Beard some time ago pointed out the "experiment of making every man, woman, and child a politician and a theologian."

We in this country have, for the last seven or eight years, especially suffered from an excess of political writing, speech-making, and discussion, and if we aim at an honourable place in the intellectual world we must turn our attention elsewhere.

The Mason College Magazine. Vol. I., No. 2, February, 1883.

THIS second issue of the "Mason College Magazine" is a decided improvement upon its predecessor, and makes us hopeful as regards its future.

The article on "Scientific Idealism," from the pen of Miss Constance C. W. Naden, is an exceedingly able and luminous exposition of a theory which seems to be forcing itself upon the attention of thinkers. We believe that the writer will leave her impress on the philosophical literature of the age, which, indeed, stands in some need of re-casting.

A humorous article on "Spelling" contains a discussion as to the correct spelling of "calligraphy" or "caligraphy," which is now sometimes in a spirit of vulgar affectation used as a synonym for hand-writing.

At a meeting of the "Mason College Union" a paper was read by Miss Evans on "Degeneration," which, it is announced, will be printed in a future number of the Magazine. We are glad to perceive that the proposal to introduce the discussion of religious subjects was rejected by a majority of more than five to one.

A sketch of the life of Joseph Priestley, by Mr. G. Harris Morris, though in brief compass, is exceedingly good. The author justly remarks that, "in spite of the numerous discoveries of Priestley, we cannot regard him as a scientific man in the true sense of the word. His discoveries were the result of haphazard experiments performed at odd moments, usually before breakfast, and he lacked the ability to properly interpret the results he obtained.

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

"REDUCTIO AD ABSURDUM."

To the Editor of the Journal of Science.

SIR,—REGARDING the advanced scientific formula I send two syllogisms :—

The Sun is the cause of all animate existence.
Intelligence is the resulting fact of animate existence.
Therefore—the Sun is the cause of intelligence.

Intelligence is the factor of all things.
The Sun being the cause of all animate existence.
Therefore—the Sun is the maker of itself.

These syllogisms I send you by way of a nut for your correspondent, "A Lucretian," to crack. He seems apt enough to ask questions and suggest doubts (presumedly *à la Socrate*), and doubtless your readers would be glad if he would give them some of his reason and logic (*à la Platon*).

An apt observation (I think) of Lord Mahon's is in point :—"It is among men as among certain tribes of animals; it is sometimes only necessary that one of the herd should step forward and lead the way to make all the others follow with alacrity and submission.

A propos of this is the much-vexed question of "mind in animals." The real point is, What is meant by mind? There can be no question but that animals have intelligence. If they had not, unless merely *automata*, how could they exist and carry on their functions? That they have intelligence the most unobservant could not doubt; but it is mainly, if not entirely, directed to sense (sensation) results—to the gratification of appetite, preservation, affections and generation, and probably avoidance of pain. They have instincts and instinctive intelligence, which reaches the primitive stage of reasoning. All this they share

with man. The mind of man is the aggregate of all that has gone before, to which is superadded the abstract powers of reasoning on things other than those of the senses. What animal, other than man, concentrates its intelligence in the contemplation of ultimate causes?—in the contemplation of the purposes of Creation (so to speak) and of a God?

On this question (animal intelligence) the most absolute absurdities are indulged in; *vide* "Nature," "Science Gossip," the ponderous volumes of Dr. Lauder Lindsay ("Mind in the Lower Animals"), and the latest production in this class of literature by the learned zoological secretary of the Linnean Society ("Animal Intelligence"). Mr. Romanes in this work (page 29) says, of limpets, "that after every browsing excursion they return to one particular spot or home, and the precise memory of direction and locality supplied by this fact seems to justify us in regarding these actions of the animal as of a nature unquestionably intelligent."!! It might just as well have been said that the creature eats to satisfy its hunger; *intelligent* because by eating it preserves its powers. At page 25, in the same work, he remarks on the *educated* oyster closing its shell to preserve it intact on reaching Paris. In another part of the same work (page I forget) this fact is claimed and commented on as a proof of intelligence!!! There are many other passages of a like character, and so strained is the reasoning that it suggests to the mind of the reader the dilemmas of a pressed advocate, and almost leads one to think that the author (with all his reputation) is unable to distinguish between a purely sense action and a mind action; but if, on the other hand, we are to conclude that *Sensation*, *Mental Power*, and *Vitality* are merely Sun results, then we may suppose that the mistiness which is so apparent is merely the effects of Sun vibrations. Lord Mahon seems to have anticipated our scientific theorisers.

In conclusion I would say that most of the scientific theorisations are strained and bizarre, and that their object appears to be that man and his intelligence should find class in the chapter of animal degradation (Lord Brougham, "Dialogues on Instinct," says something like this); and that man, in his most intellectual attribute, is merely a *trained ape;* and that there should be excised from the mind of man all idea of other potencies than Matter and Force; and that the conception of God should be banished from his intelligent and wonderfully designed Universe. —I am, &c.,

S. Billing.

DESCENT.

To the Editor of the Journal of Science.

SIR,—How far has isolation operated on Descent? Would not the separation of one or a few pairs of individuals from the congregated species cause a more decided and rapid development of variations than if left with a large number of their own race?

There are many items possessed in general which, however, every individual does not unfailingly inherit, but this is speedily rectified in the offspring by reason of overwhelming opportunities. But if one pair were isolated the only influence at work would be contained in the parents; the vigour of their particular constitution would have full play, and their peculiarities would be inherited without any fear of counteraction by the generalities of the species, variations consequently arising much more rapidly.

There is no other explanation in domestic species, but may it not have taken place on a much more important scale? Hereditary fancies will no doubt help to keep up a species, though very often I have noticed pigeons decidedly prefer another variety to their own.—I am, &c.,

D. Y. C.

[Our correspondent's views seem essentially the same as those of Dr. Moritz Wagner, discussed in our last volume (p. 460) under the title "Evolution by Segregation."—ED.]

THE COST OF SANITARY REFORMS.

To the Editor of the Journal of Science.

SIR,—On reading a recent article on "Health in Health Resorts," from the pen of Dr. B. W. Richardson, I am forcibly reminded that enthusiasts often forget to count the cost of their projects. We are told that it is possible to make use of water-carriage for sewage without having our rivers polluted. For this purpose the learned author would have "floating tanks on the canal or river, in or connected with a steam barge which should pump from the town its sewage into the receiving-tanks, and then, when charged,

steam away with the fertilising material to depôts in the course of the river, where the material could be applied, directly or after precipitation, to the purposes of agriculture."

It may be instructive to examine what tonnage would be required thus to convey away the sewage of a large town situate on a navigable river. The daily dry-weather flow of sewage from the town in question is estimated at a minimum of 8,000,000 gallons = 80,000,000 lbs. weight, or, in round numbers, 35,000 tons. To convey this mass of liquid away we should require the constant service of 175 barges, each of 200 tons capacity, or from fourteen to fifteen every hour per working day of twelve hours. Let your readers imagine the outlay of building this fleet, and the daily working cost in wear and tear, interest, fuel, and wages, and then reflect that the ordinary expenses of the disposal of sewage, whether by irrigation or precipitation, would have to be superadded.—I am, &c.,

BEGGIATOA ALBA.

INFLUENCE OF WHITE OBJECTS.

To the Editor of the Journal of Science.

SIR,—Can any or your readers explain why a white cloth, a sheet of paper, or other white object, especially if in motion, has such a repulsive effect upon birds, wild or tame? Upon insects they seem to have a powerfully attractive influence, as anyone may observe who lays down a white cloth in a field or wood, and awaits the result.—I am, &c.,

P.

NOTES.

Some time ago M. Fouquet described an epidemic among young trout occasioned by *Ichthyophthirius multifilis*, a singular ciliated infusorial which lives parasitically on the epidermis of the trout, occasioning a fatal inflammation. M. Henneguy ("Comptes Rendus") has described another epidemic among young trout caused by a flagelliform infusorial which he assigns to the genus *Bodo*, and names *Bodo necator*. Unlike most of its tribe it cannot live in impure waters, but prefers the clear well-aërated water which is essential to the health of the trout.

M. Ch. Musset has observed in certain plants a phenomenon which he names Selenotropism. They bind and turn towards the moon in a clear night, just as they are known to incline to the sun by day.

H. Th. W. Engelmann ("Pflüger's Archiv.") has observed in *Bacterium photometricum* a well-developed sensibility for light and colour. It can even be used for testing the permeability of various bodies for the ultra-red rays. He considers that bacteria, though morphologically plants, are physiologically animals. He has observed that all parts of the human eye are transparent for the ultra-red rays, which therefore reach the retina without affecting it.

Prof. Berthelot maintains that the true element carbon is as yet unknown; that it must be of a gaseous nature; and that diamond, graphite, &c., are polymeres of the veritable carbon.

According to MM. Gerlach and Koch ("Biologisches Centralblatt"), if the shell of an egg is coated over in great part with varnish, the embryo is dwarfed, sometimes not reaching a fourth part of its normal size, whilst the head is disproportionately large.

Sir W. Hooker ("Pharm. Journal") states that the powdered capsules of *Puneeria coagulans*, a shrub common in Northern India, may be used in cheese-making in place of rennet. A decoction of 30 parts of the powder in 1150 parts of water is sufficient. A teaspoonful of this liquid is sufficient for a gallon of milk.

At the February meeting of the Entomological Society M. Perinier communicated an interesting paper on three species of *Paussus* found in ants' nests at the Cape of Good Hope. All

crepitate like the Brachinidæ, emitting a yellowish matter, which stains the fingers yellow and cannot be removed for some days, in spite of washing. Their relation to the ants seems to be rather one of mutual tolerance than of actual benefit to either party. The ants drag them back if they approach recently-hatched larvæ. On such occasions they never crepitate, but if touched with a straw they discharge with great violence, and any ants in the neighbourhood appear as if stunned.

At the same meeting was exhibited a large green grasshopper, recently caught in a conservatory, but belonging to the African genus *Conocephalus*. Though belonging to a phytophagous group it was strictly carnivorous, devouring flies, spiders, and bits of raw beef. Its introduction into England is not explained.

At the meeting of the Entomological Society, March 7th, Mr. McLachlan, F.R.S., exhibited a living specimen of *Polistes hebræus*, an Indian wasp, which had found its way to London in a cargo of bamboo.

It appears that the prothoracic stigmata of the Elateridæ are provided with trap-doors, which close the entrance to the tracheæ.

According to "Ciel et Terre" the caterpillar of *Zerene pantaria*, which feeds on the ash tree, is not at all affected by temperatures of $-30°$ to $-40°$ C. Neither birds, ants, nor any other insectivorous creatures attack them. Wet weather is the greatest hindrance to their spread.

Yponomeuta cognatella, a social caterpillar, often occasions great damage in the apple-orchards of Normandy, sometimes ruining the entire crop.

M. R. Blanchard, in a memoir presented to the Academy of Sciences, maintains that the chromatophores of the Cephalopoda do not differ in their general structure from those of fishes, batrachians, and especially saurians. The surrounding tissues take no part in their movements.

With reference to the "Cruelty to Animals Bill" the "Medical Press and Circular" remarks—"It would afford us no surprise to learn that the majority of Mr. Jesse's supporters are indignantly averse to such restrictions on their playful amusements as in the near future will be imposed." (A very different, and we believe much more correct, view than that taken by Mr. Lawson Tait.)

Prof. Nordenskiöld intends visiting Greenland in August next, with the intention of penetrating into the unknown interior, which he believes cannot be permanently glaciated below 80° north latitude.

An Exhibition of Insects is to take place in July next, at the Palace of Industry, in Paris, under the auspices of the "Central Society of Agriculture and Insectology." (Insectology! a vile word.)

According to "Les Mondes" an Italian *savant* pronounced a specimen of gold submitted to him to be yellow mica, because "Science does not admit the possible occurrence of native gold in Eocene formations."

According to "l'Electricité" Fra Paolo Sarpi is said to have anticipated some of the results of Gilbert on magnetism.

We quote the following letter from "Light" (January 27th):—"Last evening I had been to see a sick friend, and left at ten o'clock. At about 10.30 I was passing a churchyard about two miles from the city, and noticed a light in the churchyard. As the gate was fastened I scaled the wall and walked towards the light, when it moved on, waving slightly, as a flame would. The light was of a phosphorescent colour, and was about 5 ft. in height and an irregular width of about 18 inches. It moved slowly across the graves with a sliding motion, in an easterly direction towards the wind, which showed it was not an *ignis fatuus*. It disappeared near a yew fence." (The circumstance of the light moving against the wind does not disprove that it was an *ignis fatuus*, except to persons who refer this phenomenon to a luminous gas. The season of the year, however, does not agree with the theory of phosphorescent insects.)

We learn from an esteemed medical contemporary that, in St. Pancras at least, undertakers play a prominent part in the Anti-Vaccination movement.

Dr. Cullen, of Kundwa, on examining 430 railway officials in India for colour-blindness, found among the half-breeds (Eurasians) 1·6 per cent, among Mahomedans 7·31 per cent, and among Hindus 3·16 per cent, suffering from this defect. Among 471 boys he found 2·54 per cent incapable of distinguishing colours, and among 68 girls none.

According to the experiments of Dr. Tarnier, as quoted by the "Medical Press" from an American journal, it is possible to produce giants to order. The child is kept in the dark, at the constant temperature of 85° F. It grows rapidly, and doubles its weight in about six weeks. It is asserted that six months of this treatment do as much for the development of a child as eight years of ordinary life!

The Scottish Educational Congress has passed the very sensible resolution that the present educational demands are calculated to be prejudicial to the health of children.

If the human will can produce effects without the intervention

of bodily organs, why may not the will of other animals do likewise? Possibly we have here the explanation of the so-called fascination of serpents.

H. van Wielowiejski ("Zeitsch. Wissen. Zoologie") has made a thorough anatomical and physiological study of the Lampyridæ. All the species examined have in their mature state a very imperfect development, containing organs otherwise peculiar to larvæ. The luminosity cannot have the object of sexual attraction, as it is shared by larvæ immediately on leaving the egg. The luminous organs are homologous with the fatty bodies in other insects.

Mr. W. B. Cooper ("American Naturalist") makes some interesting suggestions on the possibility of teaching brutes the use of letters.

According to the "New Hampshire Gazette" a toad, having observed that flies were attracted by moistened meal which was given as food to a brood of chickens, contrived to roll himself in the saucer, and thus became a living and very efficient fly-trap.

The "American Naturalist" quotes, from an essay by the late Chauncy Wright, the following passage:—"According to Mr. Spencer's views the first strata, had they been preserved, would have contained the remains of Protozoa and Protophytes; but for aught we dare guess they might have contained the foot-prints of archangels." Our contemporary adds in comment:—"Truth is stranger than fiction. What else can be the Carson foot-prints?"

Prof. Mallet, in an official report on the chief processes used in the chemical analysis of drinking water, concludes that "it is not possible to decide as to the sanitary quality of a water by the mere use of a process for the estimation of organic matter and its constituents."

The spider crab of Japan (*Macrocheira Camperi*) has been known to reach the lengths of 10, 11, and even 15 feet.

ERRATUM

Page 86, line 13, for *Pinchæta* read *Perichæta*.